



DEMOGRAPHIC RECONCILIATION IN MEXICO 1950



DEMOGRAPHIC RECONCILIATION in Mexico 2050

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***Demographic reconciliation of Mexico
1950-2015***

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Presentation

Demographic, economic, and social planning in Mexico requires a thorough study of demographic dynamics. Understanding the size, age and sex structure, and distribution of the population in the medium and long term are essential for adequately forecasting the population's needs and demands in areas such as health, education, employment, housing, and transportation. One of the basic requirements for obtaining the most accurate future population estimates possible is a solid demographic reconciliation based on reliable demographic information and methods.

As part of its powers, established in Article 37, Section II of the Regulations of the General Population Law, whenever a source of information is available that lists the population of the country, the General Secretariat of the National Population Council (SGCONAPO) updates the volume and structure of the population at the national level and of its 32 federal entities, reporting on the levels and trends of mortality, fertility and migration of the country, based on information obtained from censuses and population counts and other sources, such as administrative records and specialized surveys.

Thus, the SGCONAPO, in collaboration with El Colegio de México (COLMEX), the Mexican Society of Demography (SOMEDE), and with support from the United Nations Population Fund (UNFPA), undertook the task of carrying out the Demographic Reconciliation 1970-2015, which harmonizes the trends of the three demographic phenomena with the population by age and sex enumerated in the population censuses from 1950 to 2010, the population counts of 1995 and 2005, and the 2015 intercensal survey. To carry out this work, they relied on the invaluable knowledge and experience on the subject of Dr. Virgilio Partida Bush, who, with the collaboration of Dr. Mier y Terán regarding state fertility, formalized this project.

As part of the work carried out for Demographic Reconciliation, and with the aim of making this process transparent, workshops were organized to discuss and reach consensus on information sources, current estimates, and recent trends in internal and international migration, fertility, and mortality. These workshops included the participation of academics and officials from other agencies, including the National Institute of Statistics and Geography (INEGI), the Ministry of Health (SS), the Migration Policy Unit (UPM), and the National Migration Institute (INM).

The result of these efforts is this document which details, step by step, the process developed to carry out the Demographic Reconciliation of the country for the period

1970-2015, which aims to provide all the essential elements for making future population estimates and understanding its dynamics. We hope that reading this publication will allow for an understanding of the country's demographic past and how it influences the current and future behavior of national demographic dynamics.

Patricia Chemor Ruiz
Secretary General of the National Population Council

Introduction

Population projections, growth, and age structure are a fundamental tool for demographic, economic, social, and political planning. Population forecasts allow for the calculation of future needs in areas such as education, employment, housing, health, and social security, among others, as well as their territorial distribution. Furthermore, demographic projections enable the analysis of the effects of variations in fertility, mortality, and migration on the age composition of the population.

To achieve greater certainty, demographic projections need to be updated whenever new evidence emerges regarding the levels and trends of the factors driving demographic change. The results of the 2015 *Intercensal Survey* necessitate a review not only of the projections previously generated by the National Population Council, but also of past estimates of demographic dynamics.

Before developing population projections, it is necessary to have a reliable initial population figure in terms of size and age structure, which is derived from a demographic reconciliation exercise. This document presents the procedures and results of the demographic reconstruction of Mexico from 1950 to 2015 and of the federal entities from 1970 to 2015. The reconciliation consists of harmonizing trends in mortality, birth rates, and international and interstate migration with the population by age and sex listed in the population censuses from 1950 to 2010, the population counts of 1995 and 2005, and the 2015 survey. The shorter time frame at the state level is due to the limited availability of internal and international migration data prior to 1970.

The procedure is first carried out for the entire country, and then for the federal entities. This approach is necessary because some state-level deficiencies—especially in mortality—are offset at the national level. Once the national population and its associated demographic phenomena have been reconciled, the state-level estimates consist of superimposing appropriate territorial distributions on both the actual number of inhabitants and the figures for births, deaths, and migration.

1950 is chosen as the starting year because much of the demographic information is not comparable to that collected previously. The population dynamics from 1950 to 2015 allow for a demographically consistent age structure over those years.

¹ For part of the correction of the level of mortality (chapter 2), deaths from vital statistics from 1930 onwards are used.

65 years, in addition to offering the wealth of information on which the hypotheses of the future evolution of mortality, fertility and internal and international migration will be established for the new population projections of the country and its federal entities.

1. The populations counted in the census

Among developing and some developed nations, Mexico holds a privileged position due to the long history of its demographic statistics. Among the various data sources, the 13 modern population censuses stand out, with the regular, decennial data collection of the last eleven placing our country in a prominent position globally.¹ⁿ In addition to population censuses, similar exercises, called population counts, have been conducted in Mexico in the mid-2000s, and the 2015 *Intercensal Survey*, which have allowed for a better understanding of the country's demographic dynamics, as well as the revision of current population projections and the development of new ones.

As in many other nations, Mexico's census and population count data suffer from deficiencies that, while they have been addressed over time, still persist in the most recent counts. The shortcomings in Mexico's censuses and population counts fall into three main areas: omission of individuals; inaccurate age reporting; and imprecise collection of personal characteristics and housing information.

The shortcomings in the enumeration process and the collection of information on dwellings and their occupants are widely acknowledged; however, few efforts have been made to evaluate these shortcomings beyond the mere omission of individuals and the misreporting of age. One of the few evaluation exercises was carried out by the National Institute of Statistics, Geography and Informatics (INEGI), which convened experts from the institution itself, the academic sector, and international organizations to inspect in detail the results of the 10th General Population and Housing Census of 1980 (INEGI, 1986), paradoxically the count that perhaps had the lowest coverage and the lowest quality of information collected of all modern censuses and counts.

In this chapter, we focus on examining the erroneous reporting of age and addressing a primary issue related to census omissions: the assignment of the number of people, and their distribution by age and sex, living in dwellings presumed to be occupied, but whose occupants could not be counted. A second source of omission concerns the exclusion of household members, either due to oversight by the respondent or because they believe that some people “don’t count” for the census. This omission is rectified through intercensal reconciliation, which is presented in Chapter 5.

¹ⁿ The exception to the ten-year uprising occurred in 1921, when it had to be postponed for a year due to the armed struggle of the Mexican Revolution (1910-1921).

1.1 Allocation of population in non-census dwellings

Prior to conducting a census or count, an enumeration of habitable housing units is generally carried out. In Mexico, this housing registration exercise was formerly part of the census planning process; however, in recent years, to reduce costs, the economic censuses or the updating of sampling frames are used to compile the “enumeration of dwellings and buildings.” The resulting housing stock list serves as a reference frame for controlling the fieldwork of the census or population count itself, as well as the sampling frame for the 2015 Intercensal Survey.

Through direct inquiry with neighbors, during the census, it is verified whether a dwelling on the list, or a new one not appearing there after repeated unsuccessful attempts to enumerate its occupants, is indeed inhabited or uninhabited. It is through this procedure, along with the explicit refusal of some people to be counted (generally due to distrust stemming from the growing insecurity in the country), that the inhabited dwellings that could not be enumerated are counted.

The counting of these dwellings, however, has only been reported in the results of the 1990, 2000, and 2010 censuses and the 1995 and 2005 counts. In reality, there is little—almost no—information available regarding fieldwork in the censuses prior to 1990. Even though INEGI publicly acknowledged the adjustment to the 1980 census (Jarque, 1990), the institution's archives contain no document that accurately accounts for the population actually enumerated in the census and that which was added when generating the final tables in the enumerations from 1950 to 1980.

Knowing the number of uncounted occupied dwellings allows for a closer look at the country's demographic reality; however, two problems remain to be solved: first, the number of people living in these dwellings; second, their distribution by age and sex. For each census exercise, INEGI has assigned a different number of occupants, dividing them almost equally between men and women, but in all cases, it has included all housing and personal variables—including age—in the “unspecified” category in the microdata databases. In 1990, 1995, and 2010, three people were assigned to each dwelling, alternating between two men and one woman and two women and one man in each pair of successive dwellings, except in 12 municipalities of Chiapas in 1995.² In 2000, the state average was assigned (all states with four, except Chiapas with five), and in 2005, the municipal average.

The number of occupied dwellings not included in the census varies from one enumeration to another: 136,341 in 1990, 28,634 in 1995, 425,724 in 2000, 647,491 in 2005, and 448,195 in 2010. INEGI refers to these dwellings as “pending,” since interviews with their occupants were not conducted during the census. Table 1.1 shows the count of pending dwellings by state. The low number of pending dwellings is noteworthy.

² Each household in Acala and Chiapa de Corzo was assigned 4 people; from Amatenango del Valle, Larráinzar, Motozintla, Tapalapa and Tila 5; Chilón 5.23, Palenque 4.34, Pantelhó 4.38, Sitalá 4.81 and Yajalón with 4.79.

In Chiapas in 1995, the census (centered on November 5) took place almost two years after the Zapatista Army of National Liberation (EZLN) uprising. The publication of the 1995 census for Chiapas acknowledges that the results for 15 municipalities “were prepared using statistical and demographic methods; they are presented in aggregate form and will be further developed later” (INEGI, 1996: 9).³

During the 2010 census, at the end of each of the four weeks of the operation, INEGI (the National Institute of Statistics and Geography) tracked the status of occupied dwellings, noting whether they had been counted or were still pending. This tracking revealed which dwellings, which were ultimately counted, had appeared as “pending” in some of the earlier checks. Data on the number of occupants and their age and sex distribution were extracted for these dwellings. Table 1.2 presents some indicators for this population by state.

The average number of occupants per dwelling varies within a relatively narrow range among the states, from 2.85 in Veracruz to 3.65 in Tlaxcala. The greater presence of women is consistent with the gender distribution in the total population surveyed. Figure 1.1 shows the age pyramid of the population interviewed from the third visit onward, which we used as a reference for imputing the occupants of the remaining dwellings. The four states with the most dissimilar age structures were selected.

Assuming that the occupancy patterns of the remaining dwellings changed little between 1990 and 2010, the same average number of occupants per dwelling from the 2010 census (first column of Table 1.2) and their respective age and sex composition were adopted for each state separately. The results for the total population of each state are shown in Tables 1.3 to 1.7.

Because the average number of occupants attributed to the pending dwellings was higher than that originally assigned by INEGI, the population obtained here is somewhat larger than the figures published in 1990 (31,998), 1995 (1,504), and 2010 (101,031). However, since the attributed average is lower than the average number of occupants assigned to the census dwellings in the publications, the resulting population figure here is lower than in 2000 (328,524) and 2005 (531,342). The final populations consist of the sum of the population actually enumerated plus the population attributed to the pending dwellings.

³ Altamirano, Bochil, El Bosque, Chanal, Chenalhó, Huixtán, Huitiupán, La Independencia, Las Margaritas, Ocosingo, Oxchuc, Sabanilla, Simojovel, Tumbalá and San Juan Cancuc. The total number of homes assigned to these municipalities amounts to 88,922.

⁴ The linear correlation coefficient of the masculinity index (men per hundred women) between the populations listed in the first visit and from the third visit onwards (assimilated to pending housing) is 0.903.

Federal entity	Housing					Percentage of the country total					Percentage	of the total number of private homes in the entity			
	1990	1995	2000	2005	2010	1990	1995	2000	2005	2010	1990	1995	2000	2005	2010
Mexican Republic	136 341	28,6 34	425 724	647 491	448 195	100 00	100 00	100 00	100 00	100 00	0.84	0.1 5	1.94	2.6 7	1.57
Baja California												0.1	0.55	1.3	0.4
Baja California	1072	212	682	5,986	3033	0.7	0.7	0.1	0.9	0.68	1.57	0.2	0.65	4.4	1.70
Campeche	2,326	265	883	1955	2033	1.7	0.9	0.2	0.3	0.45	2.11	0.1	0.56	1.0	0.95
Coahuila	3 206	709	5071	9035	12,3	2.3	2.4	1.1	1.4	2.74	0.79	0.1	0.93	1.4	1.69
Colima	1,385	38	7444	4982	2530	1.0	0.1	1.7	0.7	0.56	1.54	0.0	5.63	3.3	1.40
Chiapas	2,356	2994	27,120	24,42	18,3	1.7	10.	6.3	3.7	4.10	0.39	0.4	3.36	2.6	1.68
Chihuahua	9851	962	21,764	37,81	33,7	7.2	3.3	5.1	5.8	7.53	1.82	0.1	2.88	4.4	3.57
Mexico City	7 521	4	27,326	68	64,4	5.5	14.	6.4	10.	14.3	0.42	0.2	1.28	2.9	2.6
Durango	747	340	2802	4883	9210	0.5	1.1	0.6	0.7	2.05	0.28	0.1	0.86	1.3	2.26
Guanajuato	13,09	858	6916	11,69	9812	9.6	3.0	1.6	1.8	2.19	1.87	0.1	0.75	1.1	0.7
Warrior	9417	264	6 183	10,72	5	6.9	0.9	1.4	1.6	1.15	1.84	0.0	0.94	1.5	0.6
Gentleman	3844	346	2,633	6,526	6,75	2.8	1.2	0.6	1.0	1.51	1.05	0.0	0.53	1.1	1.01
Jalisco	13,35	2,37	13,816	43	27,9	9.8	8.3	3.2	6.7	6.23	1.28	0.1	0.99	2.7	1.52
Mexico	4325	3834	149,44	139,6	60	3.1	13.	35.	21.	13.4	0.23	0.1	5.17	4.3	1.60
Michoacán	11,96	1,36	8275	15,70	15,7	8.7	4.7	1.9	2.4	3.51	1.77	0.1	0.97	1.7	1.46
Morelos	1059	81	13,142	15,90	8062	0.7	0.2	3.0	2.4	1.80	0.43	0.0	3.58	3.9	1.72
Navarit	2,766	115	583	3727	2365	2.0	0.4	0.1	0.5	0.53	1.61	0.0	0.27	1.5	0.8
Nuevo León	4,619	377	9423	17,37	19,4	3.3	1.3	2.2	2.6	4.35	0.71	0.0	1.06	1.7	1.61
Oaxaca	1,300	659	2339	9 631	7065	0.9	2.3	0.5	1.4	1.58	0.22	0.1	0.32	1.2	0.7
Puebla	1931	402	36,599	26,11	18	1.4	1.4	8.6	4.0	4.02	0.25	0.0	3.44	2.1	1.30
Querétaro	1882	516	2991	9801	4120	1.3	1.8	0.7	1.5	0.92	0.96	0.2	1.00	2.7	0.9
Quintana Roo	2898	391	2828	35	6,16	2.1	1.3	0.6	5.4	1.38	2.74	0.2	1.33	12.	1.67
San Luis Potosí	2287	904	2,687	4972	7	1.6	3.1	0.6	0.7	1.67	0.60	0.2	0.55	0.8	1.17
Sinaloa	3 205	324	2044	18,88	3	2.3	1.1	0.4	2.9	0.71	0.75	0.0	0.36	2.9	0.4
Sonora	4 153	245	2415	14,44	6440	3.0	0.8	0.5	2.2	1.44	1.08	0.0	0.46	2.3	0.9
Tabasco	1008	505	2016	4871	8061	0.7	1.7	0.4	0.7	1.80	0.35	0.1	0.49	1.0	1.42
Tamaulipas	5 177	298	5048	20	33,0	3.8	1.0	1.1	3.1	7.36	1.05	0.0	0.74	2.5	3.66
Tlaxcala	162	121	1,170	2,358	1,69	0.1	0.4	0.2	0.3	0.38	0.12	0.0	0.60	1.0	0.6
Veracruz	6995	1,55	7920	14,74	30,7	5.1	5.4	1.8	2.2	6.86	0.55	0.1	0.49	0.8	1.53
Yucatán	998	467	1943	7,680	4039	0.7	1.6	0.4	1.1	0.90	0.36	0.1	0.52	1.7	0.8
Zacatecas	653	289	987	2318	4	0.4	1.0	0.2	0.3	0.95	0.27	0.1	0.33	0.7	1.13
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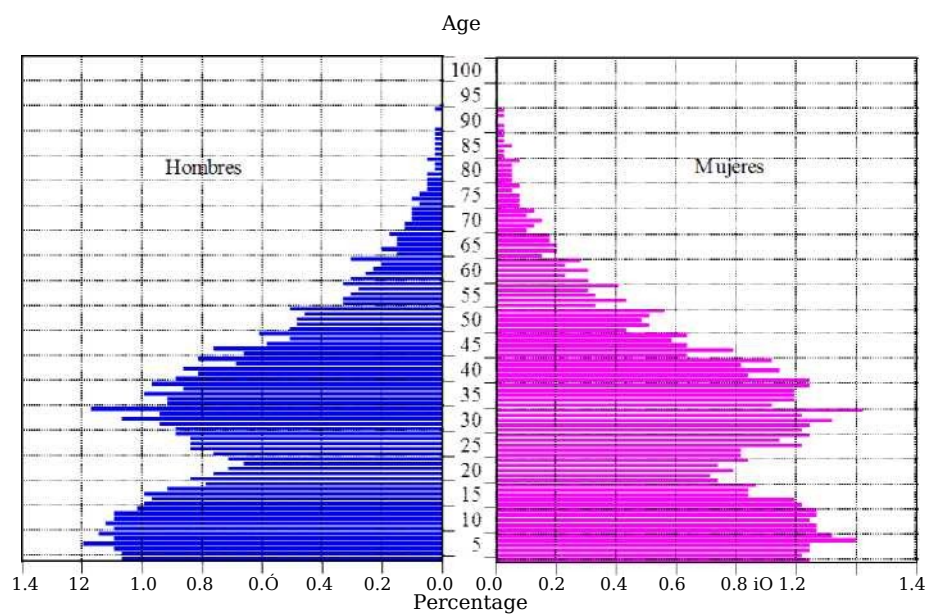
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Source: Tables from the 1990, 2000 and 2010 censuses and the 1995 and 2005 counts.

Federal entity	Occupant s per dwelling	Percentage			Middle Ages			Middle age	
		Men	Women	Total	Men	Women	Total	Men	Women
Mexican Republic	3.23	48JS	51L2	29.8	29.3	30G	28J5	28J	29.0
Aguascalientes	127	49J)	51L0	213	263	228	263	253	26.8
Baja California Sur	3.05	51.6	48.4	27.5	27.5	27.3	27.5	27.2	
Campeche	3.11	49.4	50.6	28.9	28.8	29.0	28.2	28.2	28.3
Coahuila	3.26	49.5	50.5	28.3	28.0	28.7	27.2	27.0	27.4
Colima	2.93	49.7	50.3	29.2	29.2	29.2	28.0	0.0	28.0
Chihuahua	113	414	516	2914	28/9	299	27IT~	215	2812
Mexico City	3.01	47.7	52.3	33.8	32.9	34.7	32.9	32.1	33.7
Guanajuato	33rd	486	564	216	272	284)		257	26JS
Warrior	3.25	48.3	51.7	29.4	28.9	29.9	27.4	26.6	28.1
Gentleman	3.35	48.1	51.9	29.1	28.4	29.7	27.7	26.7	28.6
Jalisco	3.32	49.0	51.0	29.1	28.6	29.6	27.6	27.1	28.0
Mexico	3.47	48.7	51.3	30.0	29.5	30.5	28.9	28.2	29.6
Michoacán	3.35	48.2	51.8	29.0	28.6	29.4	27.0	26.4	27.5
Morelos	3.21	48.5	51.5	30.7	30.0	31.3	29.0	27.9	30.0
Nuevo León	337	49 ^	512	297	294	307j		284	2839
Oaxaca	3.28	47.8	52.2	29.7	29.1	30.3	27.7	26.7	28.4
Puebla	3.36	47.8	52.2	29.4	28.5	30.1	27.8	26.5	28.7
Querétaro	3.22	48.7	51.3	29.0	28.4	29.5	28.1	27.5	28.5
San Luis Potosí	126	414	566	294)	284	296	272T~	2 G 8	281
Sinaloa	3.21	48.6	51.4	28.9	28.6	29.3	27.5	27.2	27.8
Sonora	3.18	49.8	50.2	28.7	28.3	29.0	27.2	26.9	27.5
Tabasco	3.14	48.4	51.6	29.4	29.2	29.6	28.5	28.3	28.7
Tamaulipas	3.20	49.3	50.7	29.1	28.7	29.5	27.8	27.5	28.2
Tlaxcala	3.65	48.1	51.9	28.1	27.5	28.8	26.2	25.1	27.2
Veracruz	3.02	47.8	52.2	31.3	30.6	31.9	30.0	29.1	30.7
Yucatán	3.04	48.9	51.1	30.1	29.8	30.5	28.8	28.4	29.1
Zacatecas	3.35	48.5	51.5	27.7	27.5	28.0	26.0	25.6	26.3

Source: Estimates based on information provided by INEGI from the 2010 Population and Housing Census.

Figure 1.1. Population pyramids of occupants of census dwellings
with pending history for four federal entities, 2010



Mexico City

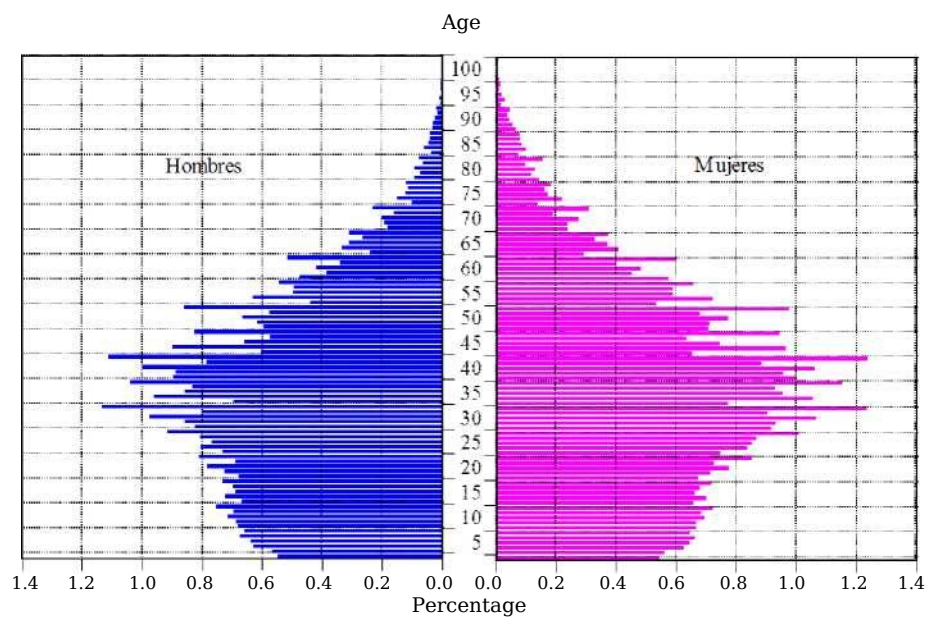
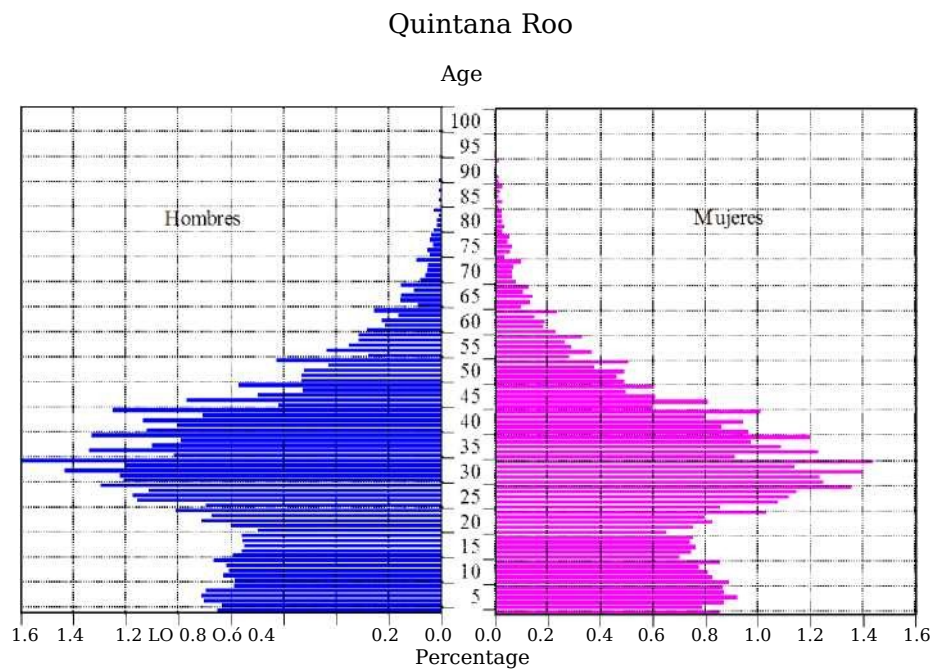
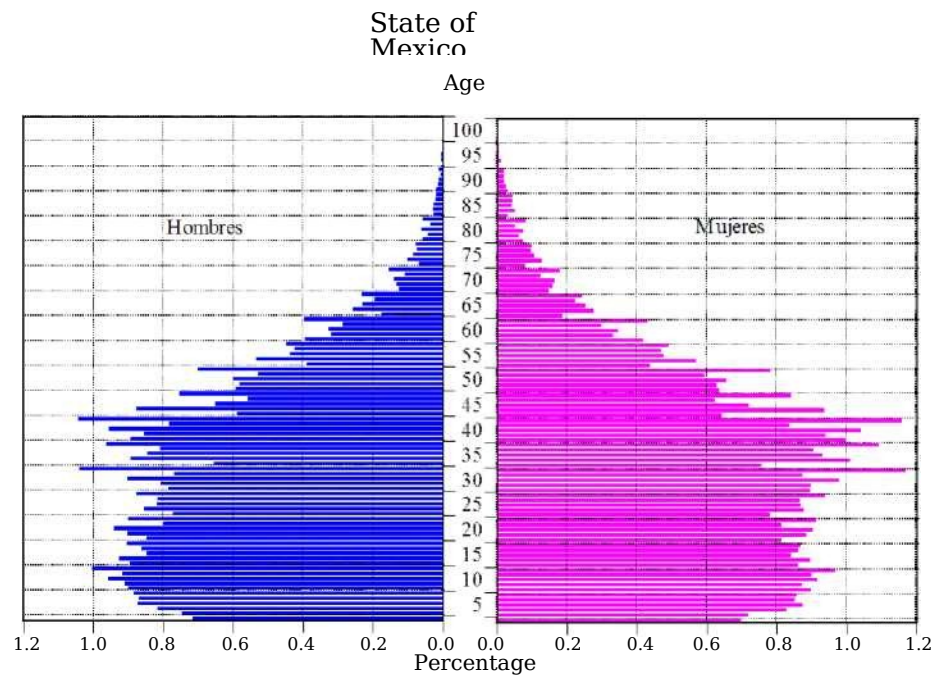


Figure 1.1.
(Concludes)



**Source: Information provided by INEGI from the 2010
Population and Housing Census.**

Federal entity	Housing		Occupants / dwelling	Population			
	Pending Census			Earring	Census*	Total	Published
Mexican Republic	16 046 969	136 341	3.23	441 021	80 840 622	81 281 643	81 249 645
Aguascalientes	129,933	666	3.27	2177	717 661	719 838	719 659
Baja California	363 363	10 113	3.10	31,353	1,630,516	1,661,86	1,660,855
Baja California	67 407	1072	3.05	3270	314 548	317 818	317 764
Campeche	107,933	2,326	3.11	7 237	528 207	535 444	535 185
Coahuila	404 885	3 206	3.26	10,456	1,962,722	1,973,17	1,972,340
Colima	88 672	1,385	2.93	4060	424 355	428 415	428 510
Chiapas	594 340	2,356	3.25	7,654	3 203 428	3 211	3 210 496
Chihuahua	530 690	9851	3.13	30 813	2,412,320	2,443,13	2,441,873
Mexico City	1,790,546	7 521	3.01	22,609	8213 181	8 235	8 235 744
Durango	262 262	747	3.39	2 534	1,347,137	1,349,67	1,349,378
Guanajuato	687 595	13,099	3.50	45 845	3,943,296	3,989,14	3,982,593
Warrior	502 337	9417	3.25	30,595	2,592,386	2,622,98	2,620,637
Gentleman	363 193	3844	3.35	12,884	1,876,834	1,889,71	1,888,366
Jalisco	1,029,965	13,359	3.32	44,412	5 262 612	5 307	5 302 689
Mexico	1,877,743	4325	3.47	14,989	9 802 820	9 817	9 815 795
Michoacán	664 457	11,961	3.35	40,069	3 512316	3,552,38	3,548,199
Morelos	245 145	1059	3.21	3403	1,191,882	1,195,28	1,195,059
Nayarit	168,588	2,766	3.05	8447	816 345	824 792	824 643
Nuevo León	642 538	4,619	3.37	15,545	3,084,879	3,100,42	3,098,736
Oaxaca	587,415	1,300	3.28	4260	3 015 660	3,019,92	3,019,560
Puebla	772 893	1931	3.36	6480	4 120 308	4,126,78	4 126 101
Querétaro	193,519	1882	3.22	6061	1,045,589	1,051,65	1,051,235
Quintana Roo	102,945	2898	2.85	8 256	484 583	492 839	493 277
San Luis Potosí	379 534	2287	3.26	7,458	1,996,326	2003784	2003187
Sinaloa	422 550	3 205	3.21	10,286	2,194,439	2,204,72	2 204 054
Sonora	378 761	4 153	3.18	13 211	1 811 147	1,824,35	1,823,606
Tabasco	285,472	1008	3.14	3163	1,498,720	1,501,88	1 501 744
Tamaulipas	488 941	5 177	3.20	16,563	2 234 050	2,250,61	2,249,581
Tlaxcala	137 182	162	3.65	591	760 791	761 382	761 277
Veracruz	1,263,240	6995	3.02	21,120	6 207 254	6 228	6 228 239
Yucatán	274 037	998	3.04	3 034	1,359,946	1,362,98	1,362,940
Zacatecas	238,888	653	3.35	2,186	1,274,364	1,276,55	1,276,323

* Includes residents of collective housing.
 Source: Tabulations from the XI General Population
 and Housing Census 1990

Federal entity	Housing		Occupants / dwelling	Earring	Population		Published
	Pending	Census			Census*	Total	
Baja California							
Campeche							
Coahuila	486,500	709	3^26	2Tnr	2T7T648	~960"	2173 775
Colima	110 443	38	2.93	111	487,914	488 025	488 028
				9727	3,570,851	3,580,57	3,584,786
Chihuahua	662 929	962	3.13	3009	2,790,651	2,793,66	2,793,537
Mexico City	2006644	4 155	3.01	12,491	8,476,542	8 489	8 489 007
Durango	299,673	340	3.39	1,154	1,430,728	1,431,88	1,431,748
Guanajuato	832 226	858	3.50	3003	4,403,994	4,406,99	4,406,568
Warrior	589 335	264	3.25	858	2,915,775	2 916	2,916,567
Gentleman	427,978	346	3.35	1,160	2 111 435	2,112,59	2 112 473
Jalisco	1,237,675	2,379	3.32	7909	5 984 039	5,991,94	5,991,176
Mexico	2,439,576	3834	3.47	13,287	11,696,462	11,709,7	11 707
Michoacán	779 781	1,362	3.35	4 563	3,866,518	3 871	3 870 604
Morelos	321 427	81	3.21	260	1,442,419	1,442,67	1,442,662
Navarit	199 239	115	3.05	351	896 357	896 708	896 702
Nuevo León	791 348	377	3.37	1,269	3,548,983	3,550,25	3 550 114
Oaxaca	651 770	659	3.28	2160	3 226 918	3 229	3 228 895
Puebla	920 805	402	3.36	1,349	4,623,159	4,624,50	4,624,365
Querétaro	250 501	516	3.22	1662	1,248,928	1,250,59	1,250,476
Quintana Roo	163,351	391	2.85	1114	702 363	703 477	703 536
San Luis Potosí	441 337	904	3.26	2948	2 198 051	2,200,99	2,200,763
Sinaloa	509 675	324	.3.21	1040	2,424,703	2,425,74	2,425,675
Sonora	474 393	245	.3.18	779	2,084,801	2,085,58	2,085,536
Tabasco	354 916	505	.3.14	1,584	1,747,254	1,748,83	1,748,769
Tamaulipas	595 541	298	3.20	953	2,526,434	2,527,38	2,527,328
Tlaxcala	171,700	121	3.65	442	883 561	884 003	883 924
Veracruz	1,462,582	1,557	3.02	4701	6 732 653	6,737,3	6 737 324
Yucatán	329 688	467	3.04	1,420	1 555 221	1,556,64	1,556,622
Zacatecas	272,789	289	3.35	968	1,335,629	1,336,59	1,336,496

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* Includes residents of collective housing.
Source: Tabulations from the 1st Population and
Housing Census of 1995

Federal entity	Housing		Occupants / dwelling	Earring	Population		Published
	Pending	Census			Census*	Total	
Mexican Republic	21 516 811	425 724	3.29	1,401,492	95 753 396	97 154 888	97 483 412
Aguascalientes	199,426	1 103	3.27	3605	939 873	943	944 285
Baja California	559 545	50 122	3.10	155 391	2,286,879	2,442,27	2,487,367
Baja California	104 382	682	3.05	2080	421 313	423 393	424 041
Campeche	156 171	883	3.11	2,747	687 157	689	690 689
Coahuila	539 251	5071	3.26	16,538	2,277,786	2,294,32	2 298 070
Colima	124,757	7444	2.93	21,824	512 851	534	542 627
Chiapas	779 011	27,120	3.25	88 108	3,785,292	3,873,40	3,920,892
Chihuahua	733 615	21,764	3.13	68 076	2,965,851	3,033,92	3 052 907
Mexico City	2 104 084	27,326	3.01	82 146	8,495,935	8 578	8 605 239
Durango	322 322	2802	3.39	9 507	1,437,453	1,446,96	1,448,661
Guanajuato	918 949	6916	3.50	24 205	4,635,368	4,659,57	4 663 032
Warrior	651 394	6 183	3.25	20,088	3 054 917	3 075	3,079,649
Gentleman	491 550	2,633	3.35	8825	2 225 059	2 233	2 235 591
Jalisco	1,378,959	13,816	3.32	45,931	6 266 738	6 312	6 322 002
Mexico	2,743,366	149,44	3.47	517,938	12,498,890	13 016	13,096,68
Michoacán	846 513	8275	3.35	27,721	3,952,567	3,980,28	3,985,667
Morelos	354 088	13,142	3.21	42 230	1,502,728	1,544,95	1,555,296
Navarit	219 236	583	3.05	1,780	917 853	919	920 185
Nuevo León	878 664	9423	3.37	31,712	3,796,449	3 828	3 834 141
Oaxaca	738 212	2339	3.28	7665	3,429,409	3,437,07	3,438,765
Puebla	1,028,780	36,599	3.36	122 810	4 930 290	5 053	5,076,686
Querétaro	295 184	2991	3.22	9633	1,392,342	1,401,97	1,404,306
Quintana Roo	210,499	2828	2.85	8057	863 651	871	874 963
San Luis Potosí	489,963	2,687	3.26	8,762	2,288,612	2,297,37	2,299,360
Sinaloa	572 887	2044	3.21	6,560	2,528,668	2 535	2,536,844
Sonora	527 522	2415	3.18	7,682	2 207 309	2 214	2,216,969
Tabasco	410 436	2016	3.14	6325	1,883,765	1 890	1,891,829
Tamaulipas	677 603	5048	3.20	16,150	2 733 030	2,749,18	2,753,222
Tlaxcala	193 302	1,170	3.65	4 272	957 966	962	962 646
Veracruz	1,597,577	7920	3.02	23,913	6 877 295	6 901	6 908 975
Yucatán	371 301	1943	3.04	5907	1,650,438	1,656,34	1,658,210
Zacatecas	298 262	987	3.35	3304	1,349,662	1,352,96	1,353,610

* Includes residents of collective housing.
Source: Tabulations from the XII General Population
and Housing Census 2000

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Federal entity	Housing		Occupants / dwelling	Earring	Population		Published
	Pending Census				Census*	Total	
Mexican Republic	24 059 465	647 491	3.23	2 094 010	100 638 078	102 732	103 263 430
Aguascalientes	242 442	3 183	3.27	10,403	1,051,831	1,062,2	1,065,416
Baja California	687 659	50,679	3.10	157 117	2,649,762	2 806	2,844,469
Baja California	129,926	5,986	3.05	18,260	489 813	508	512 170
Campeche	182 135	1955	3.11	6083	746 995	753	754 730
Coahuila	616 196	9035	3.26	29,466	2,459,445	2,488,9	2,495,200
Colima	144 207	4982	2.93	14,606	549,364	563	568 002
Chiapas	891 876	24,426	3.25	79,355	4,172,724	4 252	4 293 475
Chihuahua	814 786	37,810	3.13	118 266	3,098,669	3 216	3 241 444
Mexico City	2 219 073	68 116	3.01	204,766	8 474 137	8 678	8 720 916
Durango	353 419	4883	3.39	16,567	1,488,897	1,505,4	1,509,117
Guanajuato	1,036,853	11,690	3.50	40,913	4,839,742	4 880	4 893 812
Warrior	690 930	10,726	3.25	34 847	3 070 037	3,104,8	3 115 202
Gentleman	551 922	6,526	3.35	21,873	2 319 406	2 341	2,345,514
Jalisco	1,538,184	43 905	3.32	145,961	6,565,797	6 711	6 752 118
Mexico	3 103 934	139,63	3.47	483,916	13 414 497	13 898	14 007
Michoacán	897 681	15,709	3.35	52,624	3,899,411	3 952	3 966 073
Morelos	387 147	15,907	3.21	51 116	1 551 005	1 602	1,612,899
Navarit	240 718	3727	3.05	11,382	935 699	947	949 695
Nuevo León	996 670	17,372	3.37	58,464	4 127 139	4 185	4,199,292
Oaxaca	793 223	9 631	3.28	31,561	3,466,473	3,498,0	3,506,824
Puebla	1,181,351	26,119	3.36	87,644	5 273 465	5 361	5 383 134
Querétaro	350 152	9801	3.22	31,565	1,556,243	1,587,8	1,598,139
Quintana Roo	250 541	35 201	2.85	100 284	999 745	1 100	1,135,309
San Luis Potosí	552 562	4972	3.26	16214	2,389,642	2,405,8	2410414
Sinaloa	623 232	18,882	3.21	60,599	2,532,462	2 593	2 608 442
Sonora	600 152	14,443	3.18	45,944	2,339,387	2,385,3	2,394,861
Tabasco	468 250	4871	3.14	15 283	1,970,354	1,985,6	1,989,969
Tamaulipas	768 894	20 224	3.20	64 703	2,946,354	3 011	3024238
Tlaxcala	231 523	2,358	3.65	8609	1,057,800	1,066,4	1,068,207
Veracruz	1,763,230	14,742	3.02	44,510	7 055 023	7,099,5	7 110214
Yucatán	427 701	7,680	3.04	23,349	1,788,722	1 812	1,818,948
Zacatecas	322 896	2318	3.35	7,760	1,358,038	1,365,7 98	1,367,692

* Includes residents of collective housing.
Source: Tabulations from the II Population and Housing Census of 2005

Federal entity	Housing		Occupants / dwelling	Earring	Popul ation		Published
	Pending	Census			Census*	Total	
Mexican Republic	28 159 373	448 195	3.23	1,445,616	372,512	112 437 569	112 336 538
Hot water							
Baja California							
Baja California Sur							
Coahuila	715158		-	40TÍT~"	6279	2 751 60	2748 391
Colima	177,848	2530	2.93	7417	3 591	650 382	650 555
			3.25	59,629	9960	4 801	4,796,580
Chihuahua	910 647	33,732	3.13	105 511	11,806	3,410,78	3,406,465
Mexico City	2,388,534	64,497	3.01	193,887	57,969	8 851	8 851 080
Durango	398 471	9210	3.39	31 249	4,753	1,636,55	1,632,934
Guanajuato	1,266,772	9812	3.50	34 341	10301	5,491,27	5,486,372
Warrior	805 230	5 154	3.25	16,745	8 294	3 390	3,388,768
Gentleman	662 651	6,757	3.35	22,648	4285	2,667,39	2 665 018
Jalisco	1 802 424	27,910	3.32	92 786	33 164	7,359,73	7 350 682
Mexico	3 689 053	60 053	3.47	208 123	35,096	15 203	15 175
Michoacán	1,066,630	15,754	3.35	52,775	13,45	4,356,55	4 351 037
Morelos	460 868	8062	3.21	25,906	7803	1,778,94	1,777,227
Navarit	288,680	2365	3.05	7 222	7075	1,085,10	1,084,979
Nuevo León	1,191,114	19,484	3.37	65 571	11,449	4,660,57	4,653,458
Oaxaca	934 471	7065	3.28	23 152	7,540	3 803	3 801 962
Puebla	1,373,772	18 031	3.36	60 504	13,477	5,786,24	5,779,829
Querétaro	450 104	4120	3.22	13,269	5067	1,828,84	1,827,937
Quintana Roo	363 066	6,169	2.85	17,575	3896	1,324,64	1,325,578
San Luis Potosí	631 587	7 502	3.26	24,465	5,518	2,587,47	2,585,518
Sinaloa	709 960	3 182	3.21	10 212	9995	2,768,42	2,767,761
Sonora	705 668	6440	3.18	20,486	21,924	2,663,64	2,662,480
Tabasco	559 114	8061	3.14	25,292	5 249	2,239,71	2 238 603
Tamaulipas	868 244	33,000	3.20	105,578	11 007	3 275	3,268,554
Tlaxcala	272 507	1,695	3.65	6 188	1290	1,171,03	1,169,936
Veracruz	1,983,543	30,764	3.02	92 885	14,056	7,643,78	7,643,194
Yucatán	503 106	4039	3.04	12,279	4,687	1,955,73	1,955,577
Zacatecas	372 662	4 251	3.35	14 232	2207	1,492,14	1,490,668

* Includes residents of collective housing.
Source: Tabulations from the 2010 Population
and Housing Census

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1.2 Diagnosis of age declaration

The reporting of age suffers from two deficiencies: unspecified age and a preference for certain digits. In the population counts from 1950 to 2015, the proportion of people who did not declare their age—or whose age was not declared by a third party—is negligible: less than one percent in the thirty-two federal entities and for both sexes in the seven censuses, two counts, and the 2015 survey, except for men in Colima (1.31%) and women in Baja California (1.90%) in 1960, and men (2.13%) and women (2.50%) in Chiapas in 1980. Due to the small number of people with unspecified age, it was assumed that the error is random and that the population with unspecified age was distributed proportionally according to the reported age structure.

The age pyramids in Figure 1.2 show a preference for certain digits when reporting age, primarily 0 and 5, and to a lesser extent 2 and 8, with a corresponding rejection of the other digits. Another distinctive feature of Mexico's population age structure is the clear omission of children from zero to two years of age. Due to this particular underrepresentation, we only worked with the population aged three years and older for a more detailed examination of digit preference.

Tables 1.8 to 1.17 present the deviations from the expected 10% for each digit, derived from the application of the Myers index (Spiegelman, 1979: 77-78) to the population aged 3 to 102 years in the ten censuses. It is noted that the patterns of attraction and rejection prevail over time. The synthetic Myers index (iM)⁵, in the last column of Tables 1.8 to 1.17, shows a reduction over time in most of the federal entities; However, setbacks were observed in the 1995 and 2005 counts compared to the previous census, with the exceptions being the women of Chiapas in both counts and those of Guerrero in the first, although it should be mentioned that the women of Chiapas exhibited the highest MI in both counts and those of Guerrero only below those of Chiapas and Oaxaca in 1995. In some entities (in both sexes in Baja California, Chihuahua, Mexico City, Nuevo León and Tamaulipas and in the men of Baja California Sur and Tlaxcala), the age report was so imprecise, that the MI of 1995 was higher than that observed in 1970.

IM value was observed in men from 6 entities (Chiapas, Durango, Guerrero, Sinaloa, Tlaxcala and Yucatán) and in women from 5 (California Sur, Chihuahua, Durango, Michoacán and Sinaloa) in 2015; in 17 of men (Aguascalientes, Campeche, Coahuila, Colima, Guanajuato, Hidalgo, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sonora, Tabasco, Veracruz and Zacatecas) and 22 of women (Aguascalientes, Campeche, Coahuila, Colima, Chiapas, Guanajuato, Guerrero, Hidalgo, Jalisco, México, Morelos, Nayarit, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sonora, Tabasco, Tlaxcala, Veracruz, Yucatán and Zacatecas) in 2010; in 7 of men (Baja California Sur, Chihuahua, Jalisco, México, Nuevo León, Quintana Roo and Tamaulipas) and 4 of women (Mexico City, Nuevo León, Quintana Roo and Tamaulipas) in 2000; and in Baja California in both sexes and the men of Mexico City in 1980. And for the country as a whole in 2010 in both sexes.

⁵ The sum of the absolute values of the deviations. Hobbs (2004: 139) suggests dividing the sum by two, because the preference for one digit is offset by the rejection of others. Hobbs' suggestion is included in the last column of Tables 1.8 to 1.17.

There is no consensus on what IM values can indicate good data quality, that is, how much digital bias exists in reporting age due to ego or a third party. Based on information from *The Human Mortality Database*⁶ for six countries with recognized quality in their demographic statistics (Australia, France, England, Japan, Norway, and Sweden), during the 20th and 21st centuries, the IM —calculated by us from 0 to 109 years of age—fluctuated from 0.11 in Swedish men in 1959 to 1.97 in French men in 1931. Perhaps an IM less than three would indicate good age reporting in the federal entities, and between three and six adequate. In all entities, age reporting would be “adequate” in the last four population enumerations (except for both sexes in Chiapas in 2000 and for men in Chiapas in 2005). And in both sexes of thirteen entities (Campeche, Chiapas, Guerrero, Hidalgo, Mexico, Michoacán, Morelos, Oaxaca, Puebla, Quintana Roo, Tabasco, Tlaxcala and Veracruz) and the women of Mexico City, in none of the censuses, counts or Intercensal Survey, the declaration of age was good, that is, the IM was less than or equal to three.

The correction for misreported age is presented in section 2.2.2 within the mortality estimates in chapter 2.

⁶ <http://www.mortality.org>

Figure 1.2. Population pyramids of the enumerated population, 1950-2015

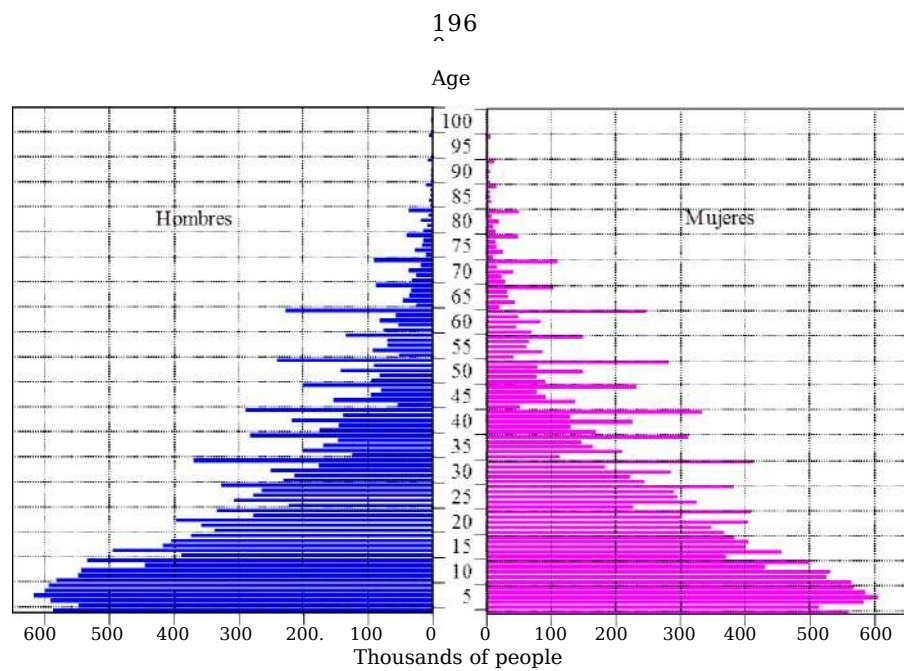
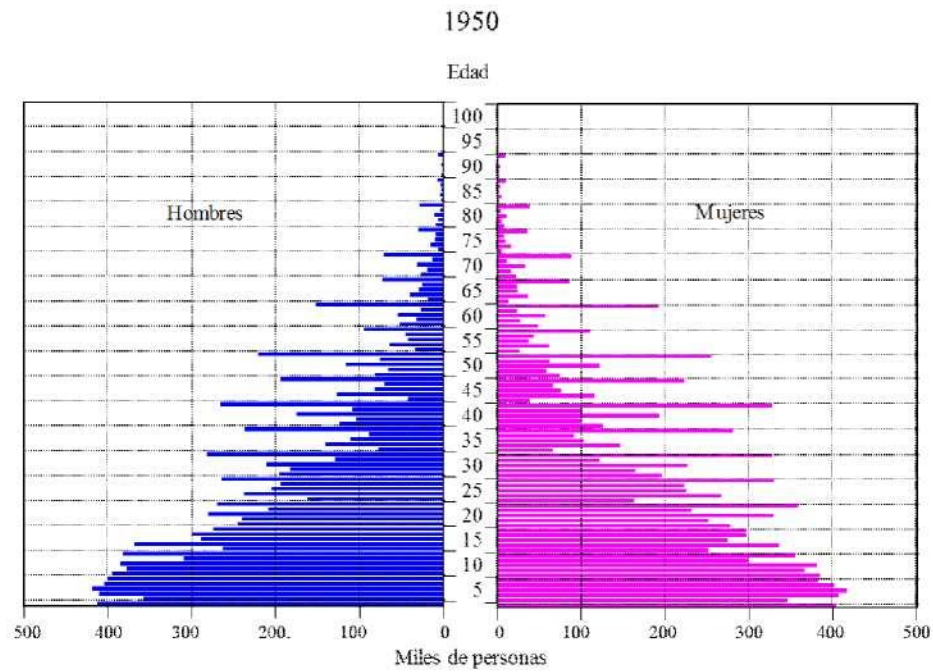


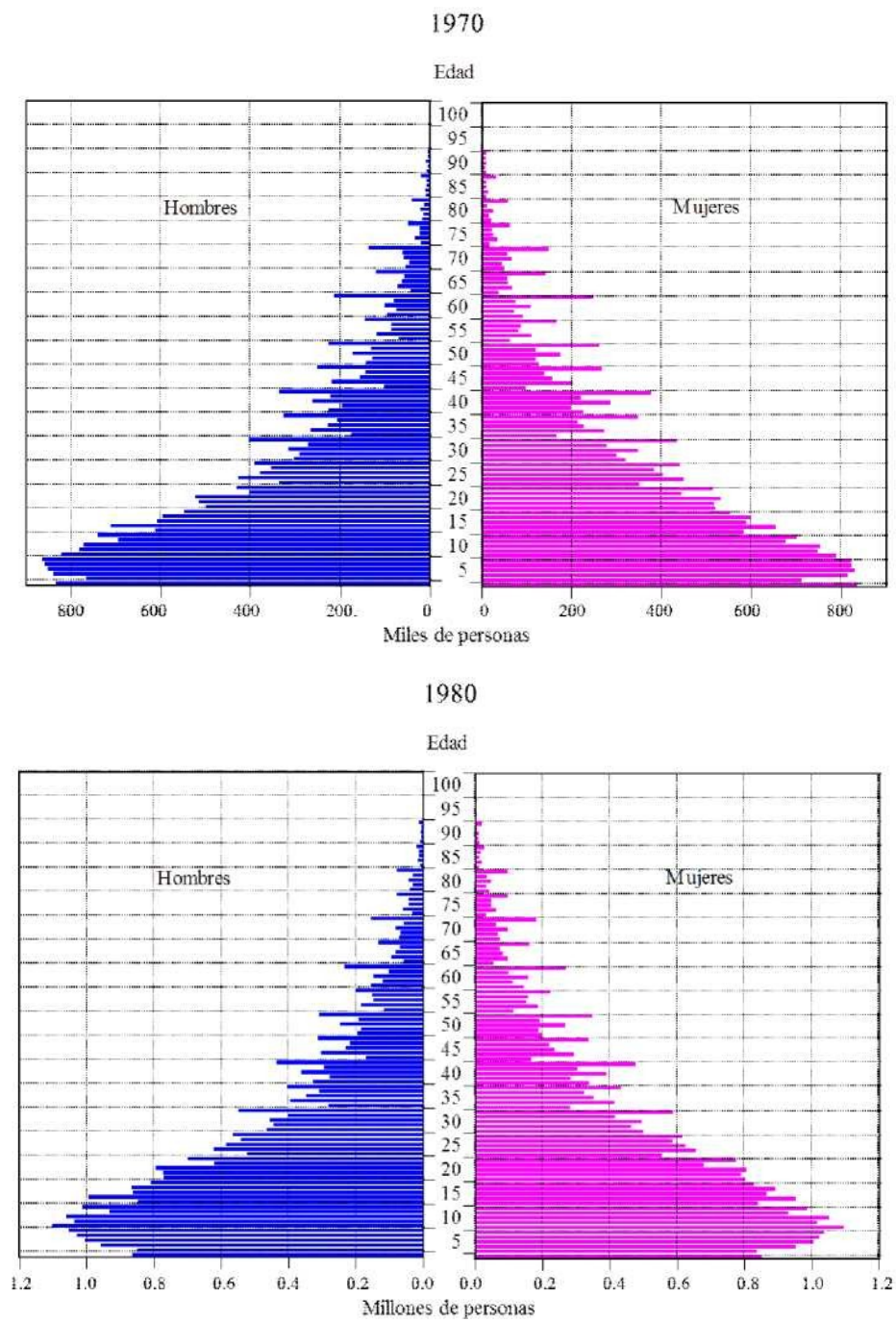
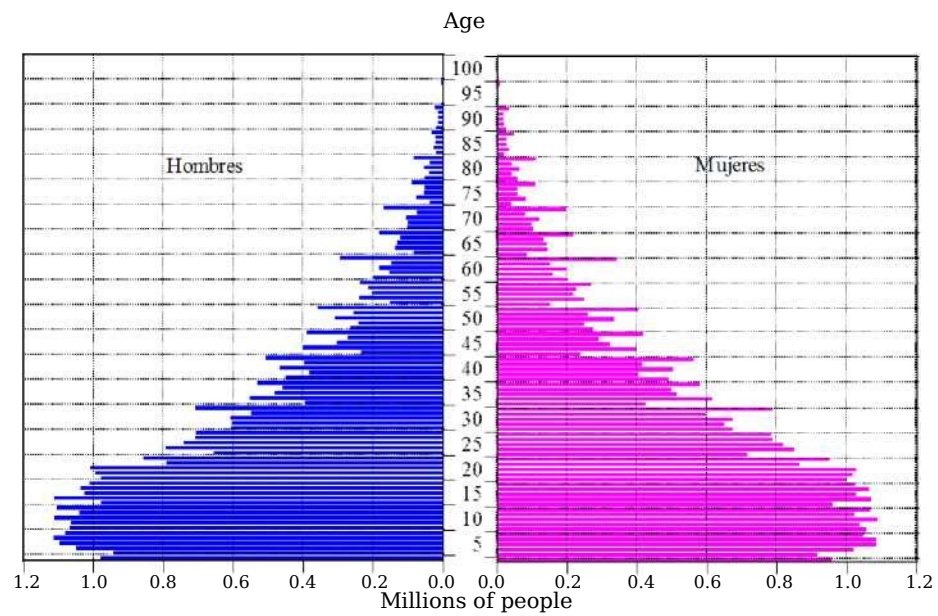
Figure
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1995

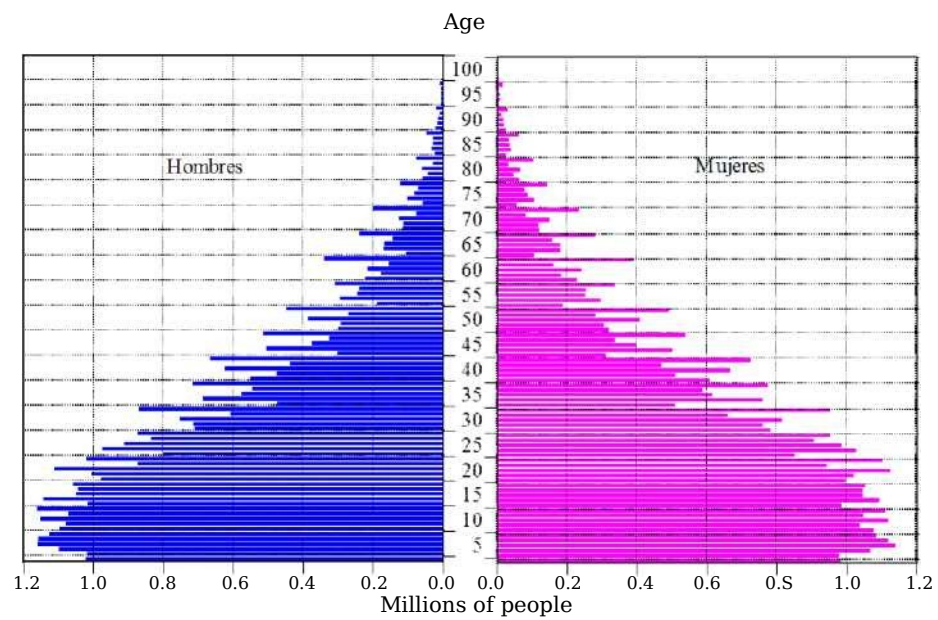


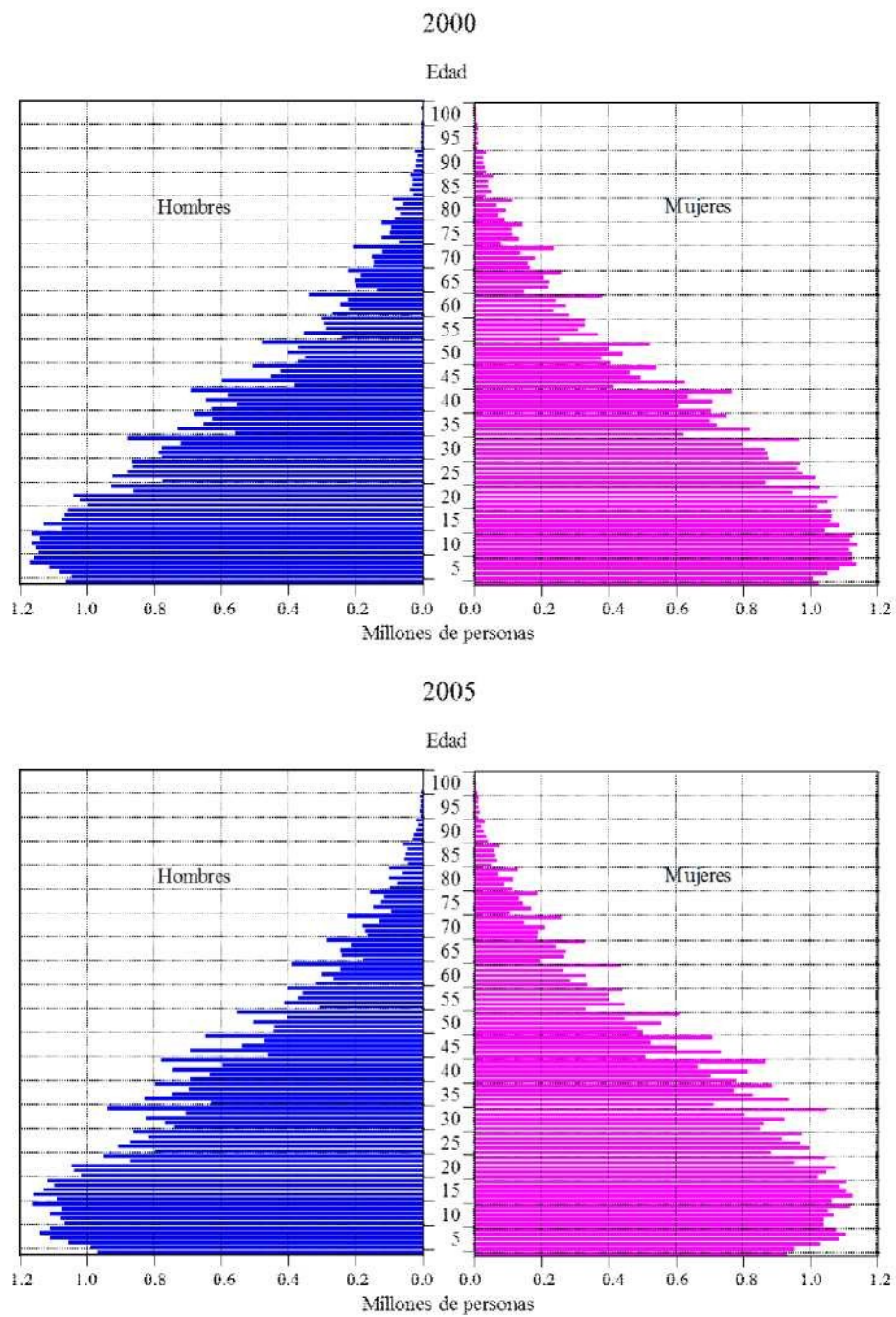
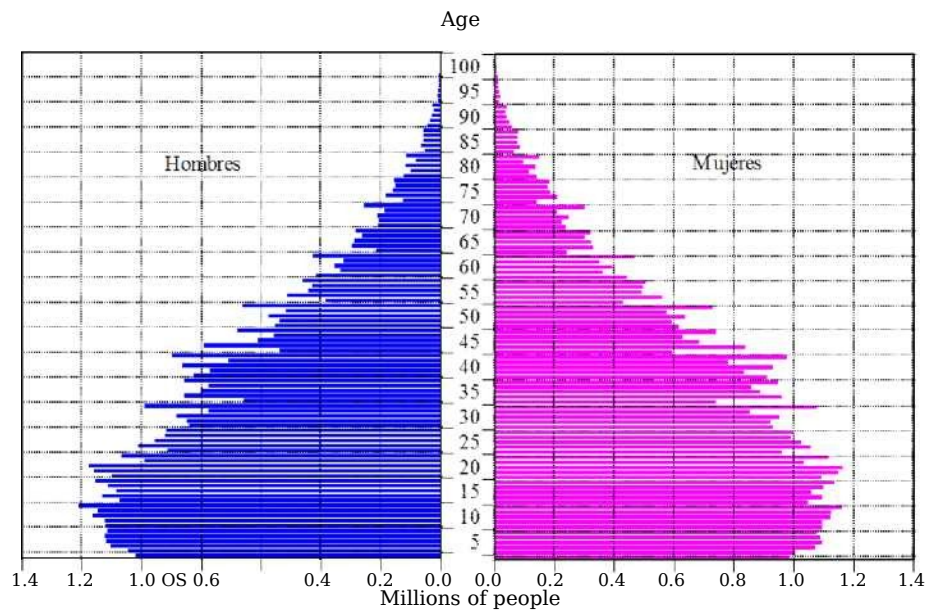
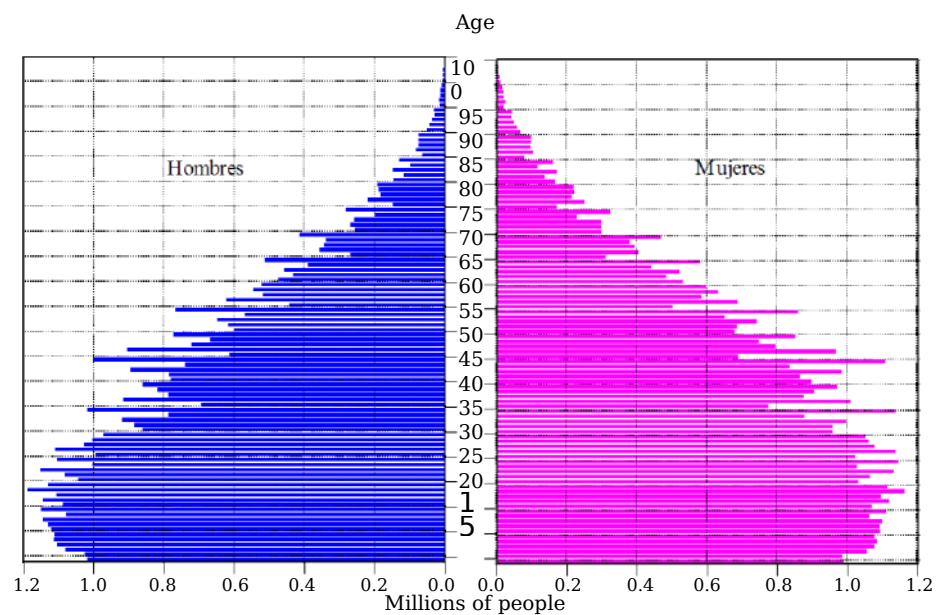
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Figure 1.2.
(Concludes)

2010



2015



Source: Population censuses 1950-2010, population counts 1995 and 2005 and intercensal survey 2015.

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Men										
Mexican Republic	6.44	-4.05	0.26	-1.66	-1.63	3.30	-0.80	-1.37	1.43	-1.92	11.43
Aauascalí entes	4.84	-3.71	0.11	-1.36	-1.13	2.24	-0.60	-0.49	1.71	-1.62	8.90
Baja California	3.35	-3.11	0.66	-0.67	-0.81	1.10	-0.27	-0.60	1.07	-0.73	6.19
Chiapas	10.5	-4.63	-0.05	-2.67	-2.62	5.75	-1.49	-3.12	1.12	-2.87	17.45
Chihuahua	4.39	-3.61	0.98	-1.19	-0.90	1.34	-0.18	-1.07	1.60	-1.36	8.30
Mexico City	2.86	-3.00	0.37	-0.85	-1.15	1.03	-0.62	-0.06	2.01	-0.58	6.26
State of Mexico	6.26	-4.69	0.49	-1.85	-1.70	4.10	-0.86	-1.41	1.78	-2.12	12.63
Michoacán	8.59	-4.73	0.05	-2.06	-1.92	4.59	-1.22	-1.80	1.28	-2.78	14.51
Morelos	6.46	-4.49	-0.01	-1.77	-1.82	4.00	-1.07	-1.34	1.92	-1.88	12.37
Nayarit	7.28	-4.45	0.06	-1.52	-1.78	2.94	-0.80	-1.60	1.60	-1.75	11.89
Nuevo León	3.96	-3.22	0.52	-1.14	-1.12	1.67	-0.36	-0.67	1.71	-1.36	7.87
Oaxaca	7.37	-3.78	-0.08	-1.99	-1.82	4.54	-1.05	-2.03	1.13	-2.28	13.03
Puebla	6.78	-4.28	0.32	-1.70	-1.90	4.26	-1.05	-1.64	1.18	-1.97	12.54
Querétaro	8.18	-4.55	0.04	-2.07	-2.00	3.00	-0.88	-1.53	1.12	-2.21	13.23
Quintana Roo	Baja California Sur	3.72	-3.15	-0.34	-1.00	-0.96	-1.74	-0.20	-0.60	-0.60	1.08
San Luis Potosí	Campeche	8.68	-4.27	-0.21	-2.45	-1.89	4.41	-0.87	-2.26	1.54	-2.66
Sinaloa	Coahuila	5.58	-4.02	0.59	-3.62	-0.80	3.46	-0.58	-1.80	0.46	-0.90
Sonora	Colima	7.24	-4.15	0.36	-4.52	-0.00	3.22	-0.73	-3.75	10.24	-1.50
Tabasco		5.30	-3.56	0.30	-1.18	-1.14	1.85	-0.57	-1.03	1.17	-1.33
Tamaulipas		6.63	-3.98	0.41	-1.99	-1.94	3.66	-0.83	-1.47	1.82	-2.32
Tlaxcala		4.32	-3.31	0.35	-1.25	-1.29	1.58	-0.29	-0.54	1.59	-1.19
Veracruz	Durango	4.07	-4.18	0.88	-1.22	-1.31	2.83	-0.68	-1.36	1.53	-1.45
Yucatán	Guanajuato	7.99	-4.59	0.06	-1.94	-1.77	3.69	-0.81	-1.37	1.24	-2.50
Zacatecas	Hidalgo	9.90	-4.74	-0.34	-2.41	-2.45	5.65	-1.53	-2.42	1.29	-2.95
	Jalisco		6.81	-4.23	0.28	-1.56	-1.44	3.16	-0.82	-1.45	1.32
											-2.08
											11.57

44

DEMOGRAPHIC RECORDS
CITATION
OF
MEXICO
1950-2015

Federal entity	Digit										Index of Myers							
	0	1	2	3	4	5	6	7	8	9								
	Women																	
Mexican Republic	8.40	-4.69	-0.37	-2.23	-1.81	4.56	-1.09	-2.07	1.79	-2.49	14.75							
Aguascalientes	6.76	-4.18	-0.32	-1.85	-1.21	3.25	-0.67	-1.30	1.45	-1.93	11.46							
Baja California	4.15	-3.43	0.16	-0.96	-0.61	1.48	-0.45	-1.06	1.32	-0.60	7.11							
Baja California Sur	5.48	-4.11	0.19	-1.39	-1.09	2.28	-0.50	-1.00	1.40	-1.26	9.36							
Chihuahua	5.40	-3.93	0.54	-1.35	-0.85	2.02	-0.50	-1.54	1.75	-1.54	9.71							
Mexico City	4.72	-3.91	0.11	-1.23	-0.97	2.55	-0.78	-1.19	1.89	-1.19	9.27							
Durango	7.49	-4.66	0.15	-1.89	-1.47	3.43	-0.69	-1.71	1.86	-2.50	12.92							
Guanajuato	9.64	-5.08	-0.56	-2.48	-1.89	5.03	-1.11	-2.17	1.69	-3.07	16.36							
Warrior	12.2	-5.39	-1.27	-3.13	-2.84	6.90	-1.75	-3.04	1.72	-3.49	20.90							
Jalisco	8.08	-4.74	-0.16	-1.93	-1.47	3.75	-0.94	-1.88	1.77	-2.48	13.60							
State of Mexico	8.47	-5.42	-0.28	-2.52	-1.96	5.67	-1.10	-2.24	2.42	-3.06	16.57							
Michoacán	10.5	-5.38	-0.71	-2.70	-2.15	5.87	-1.45	-2.44	1.78	-3.35	18.16							
Morelos	8.66	-4.99	-0.66	-2.21	-2.21	5.15	-1.39	-1.94	1.99	-2.42	15.80							
Nayarit	Campeche	8.59	-4.73	10.35	-4.27	0.02	-0.96	-2.78	-2.93	5.19	6.95	-2.25	1.94	13.32	-2.83	17.30		
Nuevo León	Coahuila	5.14	-3.74	60061	-4.10	3.8	0.19	-1.25	4.7	-10.53	2.88	-0.65	-1.36	3	1.62	5.3	-1.65	10.62
Oaxaca	Colima	10.2	-4.55	90483	-5.20	81	-0.64	-2.64	0	-11.54	4.27	-1.53	-1.37	6	1.46	7.95	-2.66	15.61
Puebla	Chiapas	8.17	-5.12	15.00	-2.54	2.02	-2.54	-1.50	1.70	-1.82	2.35	-3.80						22.24
Quintana Roo		7.76	-3.46	-1.37	-2.53	-1.84	3.61	-1.00	-1.50	1.45	-1.14							12.82
San Luis Potosí		8.68	-4.78	-0.53	-2.29	-1.86	4.94	-0.97	-2.07	1.57	-2.70							15.19
Sinaloa		8.76	-4.51	-0.28	-1.93	-1.81	3.84	-1.21	-1.91	1.37	-2.32							13.97
Sonora		6.76	-3.99	-0.08	-1.57	-1.28	2.21	-0.60	-1.25	1.24	-1.44							10.21
Tabasco		10.3	-4.70	-0.48	-3.26	-2.75	6.21	-1.25	-2.67	1.77	-3.19							18.29
Tamaulipas		5.74	-3.82	-0.11	-1.51	-1.31	2.66	-0.56	-1.34	1.55	-1.31							9.95
Tlaxcala		7.17	-4.94	0.18	-2.01	-1.70	4.65	-0.99	-2.05	2.02	-2.33							14.03
Veracruz		10.0	-4.90	-0.79	-2.71	-2.21	5.42	-1.23	-2.43	1.61	-2.76							17.03
Yucatán		9.62	-4.53	-0.67	-3.05	-2.03	4.83	-1.04	-2.25	1.84	-2.73							16.29
Zacatecas		7.82	-4.72	-0.10	-1.98	-1.48	3.69	-0.70	-1.62	1.70	-2.61							13.22

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Note: The age range considered is 3-102 years.

Source: Derived from the VII General Population and Housing Census 1950.

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Men										
Mexican Republic	5.52	-3.51	0.19	-1.17	-1.27	2.55	-0.82	-1.06	1.30	-1.73	9.56
Aauascalí entes	4.60	-3.41	0.34	-0.86	-0.86	1.65	-0.86	-0.32	1.33	-1.61	7.92
Baja California	2.27	-2.65	0.41	-0.51	-0.41	0.90	-0.43	-0.24	1.39	-0.74	4.98
Chiapas	9.81	-4.53	-0.38	-2.40	-2.49	5.18	-1.40	-2.33	1.45	-2.90	16.44
Chihuahua	3.85	-3.00	0.66	-0.81	-0.63	0.95	-0.39	-0.73	1.28	-1.18	6.74
Mexico City	2.71	-2.54	0.39	-0.38	-0.74	0.98	-0.59	-0.51	1.32	-0.64	5.40
State of Mexico	5.59	-4.14	0.26	-1.28	-1.26	3.23	-0.97	-1.21	1.66	-1.88	10.75
Michoacán	7.13	-4.11	0.00	-1.39	-1.60	3.43	-1.07	-1.26	1.26	-2.39	11.81
Morelos	5.91	-3.94	0.09	-1.30	-1.31	2.99	-1.07	-1.05	1.39	-1.71	10.39
Nayarit	6.61	-3.89	0.11	-1.40	-1.65	2.39	-0.93	-1.33	1.81	-1.71	10.93
Nuevo León	3.33	-2.64	0.54	-0.52	-0.67	1.27	-0.65	-0.70	1.13	-1.09	6.26
Oaxaca	6.88	-3.58	-0.28	-1.66	-1.66	3.89	-1.01	-1.51	1.06	-2.14	11.83
Puebla	5.20	-3.75	0.26	-1.29	-1.45	3.65	-0.94	-1.21	1.37	-1.84	10.49
Querétaro	7.17	-4.11	-0.12	-1.54	-1.65	3.50	-0.87	-1.09	0.96	-2.24	11.63
Quintana Roo	Baja California Sur		3.41	-3.01	-0.47	-0.81	-1.05	1.32	-0.36	-0.11	10.1
	Campeche		8.53	-4.05	-0.43	-2.06	-1.74	3.61	-1.23	-1.66	1.52
San Luis Potosí	Coahuila	-3.46	0.44	-3.46	-0.44	2.073	-0.992	-0.38	0.69	-0.99	1.241
Sinaloa	Colima	6.38	-3.67	0.52	-3.38	-0.32	2.134	-0.188	-2.46	10.379	-1.84
Sonora		4.80	-3.24	0.35 ⁶	-0.87	-0.80	1.25	-0.47	-0.97	1.28	-1.31
Tabasco		7.13	-3.73	-0.17	-1.91	-2.04	3.47	-1.06	-1.20	1.70	-2.17
Tamaulipas		3.97	-2.97	0.49	-0.86	-0.71	1.32	-0.52	-0.63	1.25	-1.35
Tlaxcala	Durango	4.20	-3.64	0.87	-3.62	-1.50	2.38	-0.66	-0.89	1.27	-1.37
Veracruz	Guanajuato		6.33	-3.71	-0.08	-1.21	-1.36	2.67	-0.76	-0.89	1.21
Yucatán	Guerrero		8.95	-4.25	-0.50	-1.95	-2.20	4.69	-1.39	-1.98	1.25
Zacatecas	Hidalgo		7.04	-4.31	0.22	-1.81	-1.83	4.12	-0.98	-1.61	1.42
	Jalisco		5.18	-3.46	0.36	-0.97	-1.07	2.01	-0.73	-0.90	1.32

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DEMOGRAPHIC
RECORDS
CIVIL
NOTION
OF
MEXICO
1950-2015

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Women										
Mexican Republic	6.89	-4.00	-0.33	-1.57	-1.36	3.47	-0.91	-1.61	1.44	-2.01	11.79
Aguascalientes	5.59	-3.75	0.03	-1.10	-0.79	2.61	-0.72	-1.10	1.14	-1.90	9.37
Baja California	1.76	-2.83	0.20	-0.27	-0.01	1.30	-0.38	-0.51	1.23	-0.50	4.50
Baja California Sur	4.36	-3.21	-0.31	-0.70	-0.56	1.84	-0.44	-0.91	0.63	-0.71	6.84
Chihuahua	4.4	-3.25	0.39	-0.94	-0.52	1.28	-0.51	-1.11	1.27	-1.07	7.41
Mexico City	3.8	-3.29	0.04	-0.76	-0.60	1.89	-0.68	-0.98	1.50	-1.01	7.32
Durango	6.0	-3.91	0.05	-1.20	-0.88	2.30	-0.76	-1.20	1.31	-1.79	9.75
Guanajuato	7.5	-4.18	-0.71	-1.56	-1.36	3.80	-0.80	-1.52	1.29	-2.47	12.59
Warrior	11.	-4.73	-1.23	-2.50	-2.51	5.58	-1.50	-2.58	1.50	-3.07	18.13
Jalisco	6.2	-3.85	-0.09	-1.21	-0.94	2.59	-0.76	-1.34	1.27	-1.93	10.12
State of Mexico	7.0	-4.57	-0.25	-1.78	-1.46	4.33	-0.95	-1.83	1.85	-2.42	13.25
Michoacán	8.7	-4.59	-0.52	-1.87	-1.68	4.47	-1.12	-1.90	1.26	-2.79	14.45
Morelos	6.9	-4.21	-0.55	-1.42	-1.40	3.81	-1.17	-1.58	1.53	-1.99	12.32
Nayarit	7.2	-3.99	-0.24	-1.26	-0.64	2.30	-0.91	-1.42	1.49	-2.07	11.66
Campeche	4.1	-3.07	5.03	-3.07	0.14	-0.92	-0.76	1.38	-0.70	-1.07	11.08
Nuevo León	Coahuila	9.3	-4.26	7.89	-4.54	-0.57	-1.53	-1.02	2.23	-0.95	12.84
Oaxaca	Colima	7.2	-4.26	7.89	-4.54	-0.57	-1.53	-1.02	2.23	-0.95	12.84
Puebla	Chiapas	7.2	-4.26	7.89	-4.54	-0.57	-1.53	-1.02	2.23	-0.95	12.84
Quintana Roo	6.96	-3.66	0.04	-2.17	-1.72	2.54	-0.85	-1.46	1.60	-1.29	11.14
San Luis Potosí	7.3	-4.08	-0.48	-1.75	-1.36	3.86	-0.75	-1.67	1.14	-2.21	12.30
Sinaloa	7.1	-3.89	-0.29	-1.35	-1.33	2.68	-0.97	-1.64	1.34	-1.73	11.21
Sonora	5.5	-3.58	-0.05	-1.03	-0.87	1.55	-0.42	-1.07	1.13	-1.18	8.21
Tabasco	9.1	-4.30	-0.87	-2.71	-2.43	5.23	-1.26	-2.00	1.77	-2.59	16.16
Tamaulipas	4.9	-3.33	0.01	-0.98	-0.71	1.88	-0.60	-1.10	1.13	-1.26	7.99
Tlaxcala	5.9	-4.36	0.21	-1.34	-1.67	3.65	-0.68	-1.82	1.95	-1.84	11.71
Veracruz	8.5	-4.23	-0.66	-2.05	-1.90	4.28	-1.11	-1.92	1.35	-2.28	14.15
Yucatán	8.5	-4.06	-0.52	-2.42	-2.06	4.04	-0.93	-1.89	1.70	-2.39	14.28
Zacatecas	6.4	-4.06	0.02	-1.40	-1.02	2.83	-0.54	-1.28	1.30	-2.29	10.59

THE
POPULATION
LATIN
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Note: The age range considered is 3-102 years.

Source: Derived from the VIII General Population and Housing Census 1960.

Federal entity	Digit										Myers Index		
	0	1	2	3	4	5	6	7	8	9			
	Men												
Mexican Republic	3.33	-2.68	0.39	-0.84	-0.79	1.80	-0.65	-0.69	0.78	-0.65	6.30		
Aauascalí entes	2.31	-2.52	0.54	-0.75	-0.40	1.23	-0.32	-0.29	0.64	-0.43	4.71		
Baja California	1.33	-1.93	0.65	-0.53	-0.14	0.66	-0.21	-0.26	0.47	-0.03	3.11		
Chiapas	7.3	-3.84	-0.20	-1.99	-1.98	4.36	-1.14	-1.71	1.30	-2.16	13.02		
Chihuahua	1.9	-2.19	0.72	-0.61	-0.37	0.80	-0.38	-0.51	0.60	-0.03	4.08		
Mexico City	1.1	-1.71	0.63	-0.27	-0.52	0.56	-0.42	-0.21	0.68	0.13	3.13		
State of Mexico	2.62	-2.76	0.50	-0.66	-0.73	1.62	-0.58	-0.53	0.96	-0.46	5.71		
Michoacán	4.83	-3.22	0.23	-1.05	-1.00	2.46	-0.82	-0.92	0.86	-1.38	8.38		
Morelos	3.22	-2.98	0.37	-0.90	-0.86	1.91	-0.74	-0.52	0.93	-0.44	6.43		
Nayarit	3.80	-3.22	0.44	-1.05	-0.90	1.86	-0.59	-0.78	1.09	-0.66	7.20		
Nuevo León	1.56	-1.88	0.60	-0.34	-0.25	0.64	-0.51	-0.37	0.52	0.02	3.34		
Oaxaca	5.70	-3.16	0.01	-1.38	-1.33	3.41	-1.11	-1.49	0.90	-1.57	10.02		
Puebla	4.05	-3.04	0.33	-1.09	-1.02	2.54	-0.85	-0.90	0.76	-0.78	7.68		
Querétaro	4.21	-3.18	0.17	-0.99	-1.07	2.41	-0.59	-0.64	0.64	-1.07	7.54		
Quintana Roo	Baja California Sur	1.73	-2.40	-0.44	-0.48	-0.38	0.80	-0.19	-0.01	0.32	-0.04	3.50	
San Luis Potosí	Campeche	5.59	-3.29	-0.14	-1.42	-1.23	2.66	-0.96	-0.91	0.95	-1.25	9.21	
Sinaloa	Coahuila	1.57	-2.66	0.22	-0.50	-0.78	2.07	-0.35	-0.80	0.54	-0.96	0.63	
Sonora	Colima	3.38	-2.75	0.51	-0.86	-0.39	1.04	-0.52	-0.76	0.87	-0.50	1.03	
Tabasco		2.22	-2.34	0.69	-0.68	-0.36	0.90	-0.40	-0.54	0.66	-0.15	4.47	
Tamaulipas		4.57	-3.24	0.12	-1.42	-1.17	2.52	-0.92	-0.56	1.41	-1.30	8.61	
Veracruz		2.06	-2.22	0.55	-0.71	-0.28	0.95	-0.43	-0.41	0.48	0.02	4.06	
Yucatán	Durango	2.60	-2.80	0.61	-0.54	-0.69	1.66	-0.67	-0.64	0.68	-0.27	5.65	
Zacatecas	Guanajuato	3.92	-2.93	0.23	-0.75	-0.80	2.04	-0.59	-0.60	0.58	-1.09	6.76	
	Guerrero	6.82	-3.80	-0.28	-1.70	-1.79	3.90	-1.27	-1.33	1.19	-1.75	11.91	
	Hidalgo	4.96	-3.31	0.28	-1.28	-1.29	3.29	-0.94	-1.23	0.87	-1.35	9.40	
	Jalisco		2.70	-2.51	0.56	-0.63	-0.53	1.26	-0.52	-0.56	0.78	-0.55	5.30

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DEMOGRAPHIC
RECORDS
OF
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Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Women										
Mexican Republic	4.30	-3.06	-0.10	-1.06	-0.82	2.37	-0.80	-1.00	0.96	-0.78	7.63
Aguascalientes	3.01	-2.87	0.08	-0.53	-0.39	1.71	-0.59	-0.69	0.67	-0.40	5.47
Baja California	1.76	-2.01	0.38	-0.30	-0.06	0.58	-0.41	-0.55	0.52	0.08	3.33
Baja California Sur	2.22	-2.44	0.21	-0.68	-0.27	0.97	-0.34	-0.39	0.52	0.19	4.12
Chihuahua	2.4	-2.37	0.44	-0.64	-0.26	0.84	-0.54	-0.68	0.72	0.08	4.49
Mexico City	2.0	-2.34	0.18	-0.51	-0.37	1.23	-0.52	-0.57	0.86	0.03	4.31
Durango	3.8	-3.07	0.17	-0.86	-0.39	1.64	-0.64	-0.88	0.75	-0.53	6.37
Guanajuato	4.6	-3.29	-0.20	-0.96	-0.68	2.58	-0.65	-0.92	0.74	-1.25	7.95
Warrior	8.3	-4.22	-1.02	-1.95	-1.89	4.62	-1.39	-1.76	1.34	-2.07	14.29
	3.4										
Jalisco	1	-2.81	0.14	-0.63	-0.45	1.61	-0.65	-0.79	0.81	-0.65	5.97
State of Mexico	3.6	-3.10	0.00	-0.86	-0.71	2.20	-0.70	-0.88	1.13	-0.72	6.98
Michoacán	5.9	-3.59	-0.23	-1.27	-1.14	3.12	-0.97	-1.21	0.89	-1.55	9.97
Morelos	4.2	-3.33	-0.11	-1.09	-0.79	2.42	-0.87	-0.91	MESS	-0.65	7.74
Nayarit	2.4	-3.21	5.714	-3.032	-0.604	-11.65	-10.58	3.087	-1.806	-10.48	1.2715
Nuevo León	Coahuila	2.0	-2.11	2.030	-2.038	0.009	-0.089	-0.031	1.033	-0.691	0.6381
Oaxaca	Colima	7.3	-3.78	4.252	-3.1196	-0.1182	-0.959	-0.1834	2.082	-0.741	-0.0715
Puebla	Chiapas	6.8	2.21	9.03	1.446	1.099	2.553	1.223	5.46	1.144	1.206
Quintana Roo		4.71	-2.73	-0.73	-1.60	-1.10	2.03	-0.50	-0.69	1.47	-0.85
San Luis Potosí		4.5	-3.03	-0.25	-1.14	-0.83	2.69	-0.79	-1.14	0.71	-0.78
Sinaloa		3.7	-2.83	-0.02	-0.80	-0.69	1.51	-0.66	-0.84	0.83	-0.26
Sonora		2.7	-2.49	0.31	-0.80	-0.40	0.93	-0.43	-0.64	0.71	0.03
Tabasco		6.0	-3.69	-0.69	-1.97	-1.58	3.81	-0.93	-1.07	1.59	-1.49
Tamaulipas		2.5	-2.52	0.26	-0.66	-0.23	1.15	-0.55	-0.61	0.54	0.06
Tlaxcala		3.8	-3.29	0.17	-1.01	-0.77	2.47	-1.01	-1.18	1.36	-0.63
Veracruz		5.4	-3.38	-0.37	-1.41	-1.17	3.02	-0.99	-1.22	1.10	-0.98
Yucatán		6.1	-3.39	-0.37	-1.89	-1.25	3.41	-0.99	-1.18	1.06	-1.55
Zacatecas		3.6	-3.06	0.01	-0.83	-0.41	1.92	-0.63	-0.68	0.74	-0.74

THE
POPULATION
LATINO
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Note: The age range considered is 3-102 years.

Source: Derived from the IX General Population and Housing Census 1970.

Federal entity	Digit										Myers Index			
	0	1	2	3	4	5	6	7	8	9				
	Men													
Mexican Republic	2.81	-2.33	0.42	-0.57	-0.56	1.09	-0.33	-0.54	0.83	-0.81	5.15			
Aguascalientes	2.05	-2.04	0.38	-0.44	-0.29	0.69	-0.04	-0.27	0.62	-0.67	3.75			
Baja California	1.18	-1.69	0.54	-0.22	-0.26	0.25	-0.13	-0.12	0.65	-0.21	2.63			
Chiapas	6.8	-3.78	-0.12	-1.78	-1.56	3.50	-0.80	-1.60	1.47	-2.18	11.83			
Chihuahua	1.8	-1.96	0.71	-0.32	-0.39	0.40	-0.20	-0.36	0.75	-0.47	3.71			
Mexico City	1.1	-1.48	0.50	-0.16	-0.45	0.25	-0.21	-0.12	0.62	-0.13	2.54			
State of Mexico	1.88	-2.11	0.59	-0.33	-0.41	0.64	-0.22	-0.36	0.88	-0.56	4.00			
Michoacán	4.31	-3.02	0.42	-0.93	-0.69	1.63	-0.40	-0.87	0.99	-1.44	7.34			
Morelos	2.66	-2.61	0.44	-0.61	-0.57	1.09	-0.36	-0.43	1.08	-0.69	5.26			
Nayarit	2.91	-2.60	0.47	-0.67	-0.46	1.12	-0.19	-0.62	0.86	-0.83	5.36			
Nuevo León	1.49	-1.38	0.43	-0.09	-0.30	0.25	-0.41	-0.30	0.44	-0.12	2.60			
Oaxaca	5.44	-3.25	0.18	-1.31	-1.22	2.72	-0.71	-1.31	1.26	-1.79	9.59			
Puebla	3.71	-2.78	0.38	-0.84	-0.77	1.65	-0.43	-0.72	0.99	-1.20	6.74			
Querétaro	2.05	-2.48	0.28	-0.59	-0.59	1.27	-0.27	-0.40	0.84	-1.12	5.44			
Quintana Roo	Baja California Sur	1.53	-1.88	0.41	-0.15	-0.02	0.27	-0.33	-0.15	0.69	-0.37	2.90		
	Campeche	4.91	-3.01	-0.20	-1.34	-0.98	2.23	-0.74	-0.92	1.17	-1.12	8.31		
San Luis Potosí	Coahuila	2.97	-2.36	0.37	-0.96	-0.39	1.24	-0.30	-0.49	0.20	-0.40	0.70		
Sinaloa	Colima	2.36	-2.28	0.54	-0.50	-0.44	0.76	-0.25	-0.46	0.05	-0.45	0.70		
Sonora		1.75	-1.92	0.66	-0.35	-0.18	0.24	-0.17	-0.33	0.67	-0.36	3.32		
Tabasco		3.80	-2.83	0.45	-1.10	-0.81	1.43	-0.59	-0.56	1.45	-1.25	7.13		
Tamaulipas		1.78	-1.88	0.45	-0.29	-0.27	0.44	-0.24	-0.25	0.59	-0.33	3.26		
Tlaxcala	Durango	2.73	-2.68	0.72	-0.56	-0.44	1.12	-0.28	-0.54	0.94	-0.98	0.72		
Veracruz	Guanajuato	2.64	-2.70	0.30	-0.82	-0.69	1.55	-0.41	-0.78	0.86	-1.04	6.44		
Yucatán	Warrior	3.84	-2.58	0.70	-0.60	-0.62	1.52	-0.50	-0.24	-0.30	-0.65	-1.15	5.43	
Zacatecas	Hidalgo	2.76	-2.44	0.52	-0.47	-0.37	1.06	-0.89	-0.54	-0.34	1.03	0.88	4.92	
	Jalisco			2.00	-2.02	0.57	-0.33	-0.32	0.64	-0.22	-0.34	0.61	-0.59	3.2

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DEMOGRAPHIC
RECORDS
OF
MEXICO
1950-2015

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Women										
Mexican Republic	3.34	-2.59	0.09	-0.70	-0.53	1.43	-0.40	-0.76	0.91	-0.80	5.77
Aguascalientes	2.40	-2.23	0.15	-0.42	-0.17	0.86	-0.18	-0.40	0.67	-0.68	4.08
Baja California	1.45	-1.78	0.36	-0.27	-0.07	0.37	-0.23	-0.25	0.50	-0.08	2.69
Baja California Sur	1.62	-1.85	0.27	-0.30	-0.16	0.55	-0.20	-0.33	0.46	-0.06	2.89
Chihuahua	2.1	-2.07	0.47	-0.37	-0.29	0.43	-0.19	-0.51	0.70	-0.28	3.72
Mexico City	1.8	-1.95	0.29	-0.38	-0.34	0.70	-0.26	-0.39	0.74	-0.24	3.56
Durango	2.9	-2.49	0.35	-0.51	-0.22	0.92	-0.30	-0.65	0.64	-0.67	4.84
Guanajuato	3.4	-2.74	0.09	-0.54	-0.35	1.50	-0.31	-0.70	0.68	-1.11	5.76
Warrior	6.6	-3.85	-0.47	-1.53	-1.32	3.32	-0.80	-1.44	1.35	-1.88	11:30
	2.4										
Jalisco	3	-2.19	0.26	-0.40	-0.23	0.79	-0.30	-0.52	0.70	-0.54	4.19
State of Mexico	2.3	-2.35	0.25	-0.48	-0.34	0.94	-0.23	-0.53	0.94	-0.58	4.52
	4.7										
Michoacán	5	-3.24	0.15	-0.97	-0.65	1.84	-0.45	-1.12	1.12	-1.42	7.86
Morelos	3.1	-2.81	0.04	-0.68	-0.49	1.34	-0.46	-0.69	1.22	-0.62	5.75
Nayarit	4.0	-2.59	5.004	-3.060	-0.629	-11208	-10279	20221	-0.50	-0.882	1.14.30
Campeche	1.7										
Nuevo León	Coahuila	-1.62	20279	-20040	00254	-00324	-00140	00645	-00348	-00632	0.62.82
Oaxaca	Colima	-3.79	3568	-21763	01025	-0756	-00484	11185	-01347	-02763	0.991.77
Puebla	Chiapas	7.56	1426	2074	2202	2169	422	1098	1773	1907	-2.25
											13.68
Quintana Roo	3.22	-2.43	-0.41	-0.85	-0.52	1.38	-0.28	-0.35	1.01	-0.76	5.60
San Luis Potosí	3.5	-2.61	0.11	-0.70	-0.48	1.45	-0.33	-0.77	0.63	-0.81	5.72
Sinaloa	2.6	-2.32	0.23	-0.47	-0.24	0.79	-0.28	-0.52	0.68	-0.47	4.31
	1.9										
Sonora	4.7	-1.93	0.35	-0.32	-0.19	0.41	-0.20	-0.39	0.53	-0.23	3.26
Tabasco	4.7	-3.25	-0.17	-1.33	-0.97	2.17	-0.51	-1.02	1.62	-1.26	8.51
Tamaulipas	2.0	-1.96	0.17	-0.33	-0.23	0.68	-0.32	-0.41	0.56	-0.19	3.44
Tlaxcala	3.3	-2.99	0.43	-0.87	-0.48	1.55	-0.15	-0.95	1.10	-0.98	6.42
Veracruz	4.4	-3.01	-0.09	-0.95	-0.79	1.99	-0.60	-1.06	1.10	-1.03	7.52
Yucatán	3.8	-2.84	-0.37	-0.87	-0.68	2.06	-0.42	-0.71	0.92	-0.94	6.83
Zacatecas	3.2	-2.58	0.17	-0.43	-0.25	1.13	-0.34	-0.68	0.71	-0.96	5.24

THE
POPULATION
TRENDS
SURVEY
ED

Note: The age range considered is 3-102 years.
Source: Derived from the X General Population and Housing Census 1980.

Federal entity	Digit										Myers Index			
	0	1	2	3	4	5	6	7	8	9				
	Men													
Mexican Republic	2.17	-2.30	0.45	-0.37	-0.26	0.98	-0.30	-0.41	0.68	-0.63	4.27			
Aguascalientes	0.93	-1.84	0.44	-0.15	0.03	0.56	-0.02	0.01	0.27	-0.24	2.24			
Baja California	1.21	-1.88	0.44	-0.15	-0.31	0.50	-0.17	-0.05	0.67	-0.26	2.82			
Chiapas	4.8	-3.24	0.12	-1.13	-0.86	2.16	-0.68	-1.04	1.26	-1.42	8.37			
Chihuahua	1.5	-2.08	0.53	-0.32	-0.14	0.55	-0.06	-0.24	0.64	-0.43	3.27			
Mexico City	1.1	-1.84	0.48	-0.14	-0.29	0.64	-0.14	-0.10	0.54	-0.26	2.77			
State of Mexico	1.49	-2.16	0.62	-0.20	-0.21	0.71	-0.18	-0.26	0.71	-0.52	3.54			
Michoacán	2.96	-2.69	0.53	-0.48	-0.22	1.26	-0.28	-0.64	0.67	-1.11	5.42			
Morelos	2.14	-2.66	0.51	-0.54	-0.18	1.19	-0.31	-0.34	0.87	-0.70	4.71			
Nayarit	1.94	-2.44	0.51	-0.32	-0.09	1.05	-0.12	-0.45	0.63	-0.70	4.13			
Nuevo León	1.14	-1.52	0.52	-0.04	-0.19	0.35	-0.37	-0.20	0.41	-0.10	2.42			
Oaxaca	4.02	-2.87	0.30	-0.79	-0.62	1.81	-0.69	-0.93	0.97	-1.20	7.10			
Puebla	2.94	-2.64	0.51	-0.59	-0.36	1.33	-0.50	-0.63	0.82	-0.87	5.59			
Querétaro	2.00	-2.24	0.26	-0.22	-0.25	0.93	-0.28	-0.33	0.70	-0.54	3.97			
Quintana Roo	Baja California Sur	1.16	-1.85	0.50	-0.24	-0.05	0.39	-0.26	-0.13	0.66	-0.18	2.71		
	Campeche	3.49	-2.85	0.15	-0.67	-0.44	1.43	-0.48	-0.72	1.00	-0.92	6.07		
San Luis Potosí	Coahuila	2.02	-2.19	0.34	-0.93	-0.60	0.92	-0.64	-0.50	0.30	-0.33	4.99		
Sinaloa	Colima	1.77	-2.22	0.51	-0.33	-0.68	0.82	-0.10	0.60	-0.66	3.83			
Sonora		1.32	-1.94	0.60	-0.17	0.01	0.46	-0.27	0.55	-0.25	2.93			
Tabasco		3.02	-2.73	0.27	-0.58	-0.32	1.07	-0.57	-0.62	1.27	-0.80	5.63		
Tamaulipas		1.41	-1.87	0.37	-0.19	-0.10	0.58	-0.21	-0.29	0.54	-0.24	2.90		
TLaxcala	Durango	2.15	-2.55	0.23	-0.41	-0.08	0.82	-0.27	-0.43	0.75	-0.74	4.46		
Veracruz	Guanajuato	2.05	-2.58	0.26	-0.56	-0.34	1.26	-0.46	0.95	-0.72	5.22			
Yucatán	Warrior	2.73	-2.44	0.58	-0.21	-0.24	1.08	-0.43	0.40	-0.48	4.16			
Zacatecas	Hidalgo	1.00	2.10	0.51	-0.20	0.38	0.66	0.07	0.25	0.17	0.74	3.57		
	Jalisco			1.33	-1.95	0.50	-0.19	-0.16	0.63	-0.06	-0.15	0.46	-0.41	2.92

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Women										
Mexican Republic	2.59	-2.45	0.23	-0.40	-0.20	1.19	-0.35	-0.62	0.67	-0.67	4.67
Aguascalientes	1.49	-1.92	0.29	-0.09	0.16	0.54	-0.04	-0.38	0.35	-0.40	2.83
Baja California	1.43	-1.85	0.30	-0.16	-0.08	0.63	-0.20	-0.22	0.47	-0.33	2.84
Baja California Sur	1.30	-1.75	0.37	-0.14	0.07	0.56	-0.13	-0.33	0.26	-0.20	2.55
Chihuahua	1.7	-2.12	0.46	-0.29	-0.06	0.70	-0.13	-0.42	0.53	-0.38	3.40
Mexico City	1.6	-2.17	0.39	-0.28	-0.22	0.93	-0.17	-0.32	0.54	-0.35	3.51
Durango	1.9	-2.30	0.44	-0.26	0.22	0.89	-0.29	-0.53	0.39	-0.56	3.93
Guanajuato	2.5	-2.46	0.25	-0.22	0.02	1.12	-0.34	-0.58	0.49	-0.81	4.40
Warrior	5.2	-3.49	-0.30	-1.04	-0.73	2.48	-0.80	-1.19	1.15	-1.35	8.89
	1.7										
Jalisco	6	-2.05	0.38	-0.21	-0.09	0.69	-0.15	-0.38	0.44	-0.39	3.27
State of Mexico	1.8	-2.33	0.43	-0.24	-0.09	0.94	-0.19	-0.48	0.70	-0.63	3.96
	3.4										
Michoacán	1	-2.87	0.28	-0.42	-0.19	1.40	-0.40	-0.85	0.76	-1.12	5.85
Morelos	2.6	-2.77	0.25	-0.40	-0.15	1.29	-0.38	-0.71	0.87	-0.63	5.04
	3.0										
Nayarit	Campeche	-2.24	3.53	-2.82	-0.22	-0.68	-0.38	-0.57	-0.46	-0.80	0.88
	1.4										
Nuevo León	Coahuila	-1.62	1.64	-1.07	0.18	-0.40	0.33	0.53	-0.25	-0.19	0.32
	5.0										
Oaxaca	Colima	-3.27	1.53	-2.30	0.77	-0.29	-0.08	0.94	-1.14	-0.54	0.58
	3.5										
Puebla	Chiapas	5.37	3.50	3.41	1.22	3.94	2.76	3.73	1.09	1.38	-1.53
	2.1										
Quintana Roo	2.41	-2.35	0.00	-0.26	-0.23	1.00	-0.29	-0.53	0.81	-0.56	4.22
San Luis Potosí	2.3	-2.25	0.17	-0.29	-0.07	1.08	-0.21	-0.64	0.34	-0.52	3.98
	1.9										
Sinaloa	1.6	-2.16	0.30	-0.18	0.04	0.75	-0.23	-0.52	0.49	-0.40	3.49
Sonora	1.6	-1.92	0.38	-0.23	0.11	0.46	-0.18	-0.40	0.42	-0.27	3.00
Tabasco	3.2	-2.91	0.04	-0.51	-0.24	1.28	-0.53	-0.67	1.04	-0.70	5.57
	1.7										
Tamaulipas	1.7	-1.95	0.26	-0.14	-0.01	0.69	-0.24	-0.42	0.34	-0.26	3.02
	2.4										
Tlaxcala	2.4	-2.77	0.62	-0.38	-0.13	MESS	-0.29	-0.83	0.91	-0.70	5.11
Veracruz	3.4	-2.73	0.00	-0.58	-0.34	1.45	-0.56	-0.78	0.84	-0.72	5.71
	2.7										
Yucatán	2.7	-2.54	-0.06	-0.49	-0.13	1.52	-0.27	-0.58	0.51	-0.70	4.76
	2.1										
Zacatecas	2.1	-2.17	0.34	-0.08	0.16	0.86	-0.31	-0.61	0.38	-0.72	3.89

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Note: The age range considered is 3-102 years.

Source: Derived from the XI General Population and Housing Census 1990.

Federal entity	Digit										Myers Index			
	0	1	2	3	4	5	6	7	8	9				
	Men													
Mexican Republic	2.48	-2.14	0.70	-0.27	-0.51	1.55	-0.72	-0.77	0.88	-1.22	5.62			
Aauascalí entes	1.45	-1.50	0.80	0.03	-0.26	0.94	-0.62	-0.54	0.56	-0.86	3.78			
Baja California	1.85	-1.75	0.79	-0.04	-0.53	1.28	-0.79	-0.57	0.73	-0.97	4.65			
Chiapas	4.70	-3.14	0.32	-1.06	-0.93	2.55	-0.90	-1.16	1.40	-1.79	8.96			
Chihuahua	1.99	-1.84	0.70	-0.18	-0.43	1.15	-0.52	-0.65	0.75	-0.96	4.58			
Mexico City	2.37	-1.95	1.04	-0.14	-0.72	1.61	-0.87	-0.79	0.78	-1.31	5.79			
State of Mexico	2.06	-2.01	0.95	-0.16	-0.52	1.37	-0.67	-0.75	0.90	-1.15	5.27			
Michoacán	3.08	-2.40	0.73	-0.39	-0.54	1.64	-0.77	-0.83	0.94	-1.47	6.39			
Morelos	2.51	-2.32	0.77	-0.24	-0.56	1.67	-0.82	-0.78	0.96	-1.18	5.90			
Nayarit	1.88	-1.82	0.79	-0.21	-0.50	1.31	-0.66	-0.60	0.79	-0.98	4.77			
Nuevo León	1.56	-1.60	0.66	0.03	-0.31	1.09	-0.58	-0.54	0.57	-0.89	3.91			
Oaxaca	3.85	-2.78	0.62	-0.59	-0.62	2.40	-0.98	-1.16	1.11	-1.84	7.98			
Puebla	2.97	-2.56	0.68	-0.43	-0.55	1.96	-0.80	-0.87	1.05	-1.46	6.66			
Querétaro	2.47	-2.03	0.58	-0.20	-0.43	1.47	-0.66	-0.81	0.89	-1.24	5.36			
Quintana Roo	Baja California Sur	1.45	-1.79	-0.62	-0.10	-0.20	1.26	-0.31	-0.38	0.59	-0.94	3.92		
	Campeche	3.34	-2.49	0.53	-0.47	-0.65	1.71	-0.73	-0.92	1.08	-1.40	6.66		
San Luis Potosí	Coahuila	2.26	-2.00	0.52	-0.16	-0.49	1.02	-0.48	-0.09	0.61	-0.56	0.79	4.05	
Sinaloa	Colima	2.07	-2.04	0.77	-0.80	-0.86	1.25	-0.45	-0.21	0.86	-0.94	0.82	-1.00	4.70
Sonora		1.68	-1.76	0.60	-0.05	-0.37	1.12	-0.57	-0.60	0.83	-0.89	4.23		
Tabasco		3.10	-2.69	0.61	-0.43	-0.45	1.67	-0.83	-0.86	1.23	-1.36	6.61		
Tamaulipas		1.92	-1.85	0.55	-0.15	-0.41	1.30	-0.61	-0.60	0.82	-0.95	4.59		
Tlaxcala	Durango	2.34	-2.33	0.81	-0.30	-0.47	1.65	-0.66	-0.33	1.10	-1.23	0.69	-1.03	4.71
Veracruz	Guanajuato	2.49	-2.03	0.69	-0.33	-0.46	1.45	-0.68	-0.70	0.77	-1.19	5.40		
Yucatán	Guerrero	4.37	-2.94	0.42	-0.73	-0.85	2.37	-1.06	-1.09	1.14	-1.63	8.30		
Zacatecas	Hidalgo	2.94	-2.43	0.58	-0.50	-0.64	2.07	-0.65	-0.96	1.03	-1.44	6.62		
	Jalisco	1.62	-1.70	0.81	-0.02	-0.31	1.14	-0.61	-0.56	0.65	-1.04	4.23		

Federal entity	Digit										Index of Mvers
	0	1	2	3	4	5	6	7	8	9	
Women											
Coahuila	1.92	-1.92	0.42	-0.06	-0.31	1.20	-0.44	-0.61	0.68	-0.89	4.23
Colima	2.09	-1.91	0.55	-0.07	-0.41	1.31	-0.51	-0.81	0.67	-0.92	4.62
Chianas	4.99	-3.48	-0.12	-1.00	-0.93	2.85	-0.82	-1.28	1.52	-1.73	9.36
Chihuahua	2.15	-1.97	0.52	-0.21	-0.41	1.28	-0.47	-0.65	0.70	-0.95	4.65
Mexico City	2.93	-2.24	0.87	-0.28	-0.75	1.84	-0.81	-0.99	0.81	-1.38	6.45
Duranso	2.20	-2.05	0.42	-0.10	-0.37	1.37	-0.59	-0.64	0.70	-0.95	4.70
Guanajuato	2.90	-2.25	0.48	-0.24	-0.42	1.50	-0.71	-0.85	0.77	-1.19	5.65
Warrior	4.86	-3.16	-0.01	-0.72	-0.86	2.55	-1.03	-1.28	1.19	-1.54	8.60
Jalisco	2.09	-1.83	0.68	-0.11	-0.40	1.24	-0.56	-0.70	0.58	-0.99	4.60
State of Mexico	2.20	-1.83	0.70	-0.11	-0.48	1.29	-0.52	-0.69	0.66	-1.15	5.57
República Mexicana	2.20	-1.83	0.70	-0.11	-0.48	1.29	-0.52	-0.69	0.66	-1.15	5.57
Michoacán	1.82	-1.69	0.57	-0.05	-0.40	1.12	-0.42	-0.66	0.49	-0.88	4.05
Morelos	2.07	-1.78	0.62	-0.24	-0.53	1.31	-0.63	-0.58	0.59	-0.83	4.59
Baja California	1.53	-1.60	0.54	-0.13	-0.30	0.99	-0.46	-0.32	0.49	-0.75	3.56
Nayarit	3.31	-2.52	0.22	-0.41	-0.52	1.82	-0.61	-0.99	0.96	-1.27	6.32
Baja California Sur	4.60	-3.12	0.18	-0.61	-0.76	2.77	-1.06	-1.43	1.17	-1.73	8.71
Nuevo León	3.49	-2.87	0.39	-0.48	-0.59	2.17	-0.78	-1.10	1.17	-1.42	7.23
Oaxaca	2.72	-2.27	0.35	-0.24	-0.33	1.56	-0.54	-0.91	0.87	-1.21	5.50
Puebla	2.52	-2.13	0.26	-0.18	-0.50	1.33	-0.58	-0.68	0.84	-0.89	4.95
Querétaro	2.53	-2.13	0.40	-0.13	-0.38	1.62	-0.57	-0.91	0.64	-1.06	5.18
Quintana Roo											
San Luis Potosí											

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Sinaloa	2.22	-1.97	0.34	-0.21	-0.39	1.30	-0.54	-0.69	0.78	-0.84	4.64
Sonora	1.90	-1.76	0.42	-0.10	-0.38	1.13	-0.44	-0.59	0.62	-0.79	4.07
Tabasco	3.23	-2.75	0.32	-0.39	-0.48	1.74	-0.72	-0.96	1.17	-1.16	6.47
Tamaulipas	2.21	-1.94	0.42	-0.19	-0.48	1.41	-0.46	-0.71	0.73	-0.99	4.77
Tlaxcala	2.63	-2.53	0.70	-0.39	-0.44	1.75	-0.68	-0.93	1.01	-1.13	6.09
Veracruz	3.15	-2.60	0.24	-0.35	-0.48	1.84	-0.63	-0.96	0.94	-1.15	6.17
Yucatán	3.10	-2.18	0.24	-0.46	-0.43	1.54	-0.68	-0.80	0.86	-1.18	5.74
Zacatecas	2.32	-2.11	0.41	-0.22	-0.40	1.33	-0.44	-0.70	0.73	-0.92	4.79

Note: The age range considered is 3-102 years.
Source: Derived from the 1995 Population Count.

Federal entity	Digit										Myers Index		
	0	1	2	3	4	5	6	7	8	9			
	Men												
Mexican Republic	1.73	-1.85	0.54	-0.25	-0.17	0.65	-0.33	-0.38	0.43	-0.37	3.35		
Aguascalientes	0.81	-1.47	0.38	-0.05	0.07	0.47	-0.13	-0.15	0.17	-0.10	1.89		
Baja California	1.63	-1.62	0.51	-0.37	-0.45	0.59	-0.37	-0.29	0.55	-0.17	3.27		
Chiapas	3.5	-2.59	0.40	-0.80	-0.49	1.33	-0.67	-0.78	0.94	-0.88	6.21		
Chihuahua	1.4	-1.68	0.59	-0.28	-0.29	0.43	-0.23	-0.25	0.44	-0.20	2.94		
Mexico City	1.4	-1.63	0.63	-0.27	-0.37	0.63	-0.26	-0.35	0.43	-0.28	3.16		
State of Mexico	1.4	-1.79	0.64	-0.21	-0.23	0.56	-0.30	-0.32	0.47	-0.33	3.16		
Michoacán	2.0	-2.03	0.70	-0.24	-0.05	0.76	-0.35	-0.56	0.39	-0.69	3.91		
Morelos	1.7	-2.13	0.51	-0.27	-0.07	0.73	-0.27	-0.32	0.51	-0.45	3.50		
Nayarit	1.1	-1.68	0.43	-0.19	0.04	0.63	-0.05	-0.38	0.17	-0.12	2.42		
Nuevo León	1.1	-1.31	0.49	-0.09	-0.18	0.28	-0.31	-0.22	0.22	-0.05	2.16		
Oaxaca	2.6	-2.32	0.49	-0.43	-0.19	1.02	-0.47	-0.60	0.53	-0.67	4.68		
Puebla	2.1	-2.13	0.59	-0.32	-0.15	0.81	-0.44	-0.48	0.53	-0.52	4.05		
Querétaro	1.5	-1.50	0.50	-0.22	-0.10	0.70	-0.38	-0.28	0.52	-0.41	3.28		
Quintana Roo	Baja California Sur	1.19	-1.33	-0.43	-0.18	-0.21	0.26	-0.26	-0.26	-0.21	0.02	2.39	
San Luis Potosí	Campeche	2.34	-2.20	0.49	-0.38	-0.25	0.84	-0.45	-0.46	0.69	-0.61	4.36	
Sinaloa	Coahuila	1.3	-1.77	0.38	-0.52	0.58	-0.09	-0.41	-0.37	0.130	-0.26	0.294	
Sonora	Colima	1.3	-1.64	0.55	-0.178	-0.09	0.0504	-0.0208	-0.351	0.0224	-0.35	0.267	
Tabasco		1.2	-1.52	0.45	-0.11	-0.09	0.36	-0.31	-0.23	0.35	-0.13	2.39	
Tamaulipas		2.3	-2.43	0.49	-0.32	-0.18	0.74	-0.45	-0.45	0.80	-0.56	4.39	
Tlaxcala		1.3	-1.61	0.50	-0.15	-0.13	0.46	-0.33	-0.35	0.30	-0.08	2.66	
Veracruz	Durango	1.8	-2.11	0.67	-0.27	-0.15	0.696	-0.32	-0.38	0.473	-0.45	0.368	
Yucatán	Guangjuato	1.8	-2.00	0.41	-0.28	-0.07	0.67	-0.36	-0.44	0.49	-0.28	3.44	
Zacatecas	Warrior	1.3	-1.86	0.405	-0.286	-0.088	0.033	-0.024	-0.382	0.036	-0.457	0.597	
	Hidalgo	1.3	-1.60	0.40	-0.18	-0.15	0.732	-0.14	0.10	-0.30	-0.51	0.280	
	Jalisco		1.09	-1.54	0.59	-0.16	-0.13	0.46	-0.18	-0.18	0.29	-0.23	242

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Women										
Mexican Republic	1.89	-1.93	0.40	-0.26	-0.14	0.69	-0.31	-0.48	0.45	-0.32	3.44
Aguascalientes	1.28	-1.58	0.36	-0.11	0.06	0.41	-0.18	-0.28	0.27	-0.23	2.37
Baja California	1.60	-1.57	0.37	-0.25	-0.33	0.55	-0.30	-0.34	0.42	-0.14	2.94
Baja California Sur	1.25	-1.50	0.46	-0.14	-0.11	0.34	-0.16	-0.26	0.16	-0.06	2.21
Chihuahua	1.5	-1.69	0.50	-0.36	-0.13	0.50	-0.25	-0.33	0.42	-0.19	2.96
Mexico City	1.7	-1.84	0.57	-0.36	-0.31	0.74	-0.20	-0.43	0.39	-0.30	3.44
Durango	1.4	-1.63	0.52	-0.16	0.09	0.44	-0.25	-0.42	0.19	-0.23	2.68
Guanajuato	1.8	-1.95	0.38	-0.08	0.00	0.66	-0.27	-0.48	0.38	-0.46	3.22
Warrior	3.3	-2.62	0.08	-0.51	-0.25	1.24	-0.61	-0.79	0.75	-0.64	5.42
Jalisco	1.3										
State of Mexico	1.6	-1.56	0.49	-0.16	-0.09	0.49	-0.18	-0.35	0.24	-0.22	2.56
Michoacán	2.3	-1.90	0.51	-0.27	-0.15	0.62	-0.23	-0.40	0.50	-0.31	3.26
Morelos	1.8	-2.17	0.53	-0.22	-0.08	0.73	-0.38	-0.68	0.46	-0.50	4.03
Nayarit	1.2	-2.23	0.41	-0.21	-0.15	0.84	-0.24	-0.49	0.55	-0.37	3.68
Campeche	2.2	-1.50	0.32	-0.05	0.03	-0.27	-0.23	0.056	-0.37	-0.545	0.59
Nuevo León	1.3										
Coahuila	1.3	-1.32	0.41	-0.55	0.505	-0.128	-0.035	0.029	-0.251	-0.0406	0.28
Oaxaca	3.0	-2.51	0.42	-0.742	0.521	-0.106	-0.039	0.046	-0.38	-0.561	0.35
Puebla	3.4	-2.22	0.51	-0.79	0.68	-0.74	-0.47	1.45	-0.64	-0.84	1.18
Chiapas	2.4										
Quintana Roo	1.71	-1.97	0.32	-0.22	-0.40	0.59	-0.26	-0.32	0.52	-0.26	3.14
San Luis Potosí	1.6	-1.82	0.31	-0.07	0.07	0.54	-0.14	-0.44	0.17	-0.22	2.69
Sinaloa	1.3	-1.58	0.40	-0.17	-0.04	0.54	-0.26	-0.37	0.22	-0.08	2.50
Sonora	1.2	-1.49	0.37	-0.11	0.00	0.33	-0.25	-0.26	0.24	-0.10	2.21
Tabasco	2.2	-2.38	0.28	-0.33	-0.16	0.82	-0.41	-0.54	0.78	-0.32	4.13
Tamaulipas	1.4	-1.61	0.46	-0.18	-0.09	0.41	-0.20	-0.39	0.21	-0.11	2.58
Tlaxcala	1.9	-2.19	0.55	-0.28	-0.05	0.76	-0.29	-0.68	0.63	-0.41	3.91
Veracruz	2.0	-2.05	0.27	-0.26	-0.07	0.66	-0.40	-0.51	0.46	-0.15	3.45
Yucatán	1.8	-1.89	0.31	-0.25	-0.02	0.78	-0.19	-0.45	0.30	-0.40	3.19
Zacatecas	1.4	-1.65	0.48	0.05	0.14	0.55	-0.30	-0.50	0.02	-0.27	2.71

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Note: The age range considered is 3-102 years.

Source: Derived from the XII General Population and Housing Census 2000.

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Men										
Mexican Republic	1.69	-1.63	0.66	0.03	-0.31	1.16	-0.60	-0.52	0.49	-0.97	4.02
Aguascalientes	0.89	-0.97	0.65	0.24	-0.19	0.81	-0.44	-0.37	0.14	-0.75	2.72
Baja California	1.55	-1.45	0.65	-0.02	-0.50	1.02	-0.63	-0.42	0.55	-0.76	3.78
Chiapas	3.1	-2.44	0.49	-0.34	-0.41	1.76	-0.81	-0.81	0.80	-1.40	6.21
Chihuahua	1.3	-1.44	0.63	0.03	-0.30	1.03	-0.47	-0.42	0.46	-0.88	3.51
Mexico City	1.7	-1.48	0.85	0.03	-0.54	1.09	-0.67	-0.59	0.47	-0.95	4.22
State of Mexico	1.5	-1.62	0.80	0.06	-0.34	1.04	-0.56	-0.52	0.53	-0.97	4.01
Michoacán	1.8	-1.86	0.69	-0.05	-0.25	1.34	-0.54	-0.52	0.55	-1.19	4.41
Morelos	1.8	-1.72	0.71	0.08	-0.35	1.20	-0.66	-0.61	0.52	-0.96	4.31
Nayarit	1.3	-1.35	0.54	-0.03	-0.37	1.09	-0.46	-0.35	0.44	-0.84	3.39
Nuevo León	1.2	-1.29	0.58	0.18	-0.33	0.97	-0.49	-0.40	0.33	-0.76	3.27
Oaxaca	2.3	-2.07	0.66	0.00	-0.11	1.66	-0.86	-0.76	0.57	-1.45	5.25
Puebla	1.8	-1.89	0.66	0.04	-0.19	1.33	-0.66	-0.63	0.57	-1.10	4.48
Querétaro	1.5	-1.45	0.64	0.18	-0.20	1.06	-0.64	-0.51	0.40	-1.03	3.87
Quintana Roo	Baja California Sur		1.46	-1.54	0.31	0.01	-0.40	0.94	-0.31	-0.29	0.32
	Campeche		2.39	-1.93	0.54	-0.12	-0.38	1.29	-0.67	-0.64	0.63
San Luis Potosí	Coahuila	-1.46	0.584	0.193	-0.69	0.48	-0.25	-0.88	0.96	-0.39	0.391
Sinaloa	Colima	1.3	-1.42	0.65	0.09	-0.84	0.95	-0.40	-0.84	0.58	-0.54
Sonora		1.1	-1.35	0.57	0.17	-0.31	0.86	-0.45	-0.44	0.46	-0.69
Tabasco		2.2	-2.23	0.63	-0.09	-0.32	1.32	-0.67	-0.65	0.88	-1.13
Tamaulipas		1.3	-1.32	0.53	0.06	-0.34	0.97	-0.56	-0.36	0.45	-0.78
Tlaxcala	Durango	1.6	-1.75	0.673	-0.08	-0.27	1.153	-0.57	-0.57	0.679	-0.91
Veracruz	Guanajuato	1.7	-1.82	0.52	0.05	-0.16	1.206	-0.68	-0.58	0.48	-0.97
	Warrior	1.5	-1.55	0.570	-0.244	-0.55	1.022	-0.41	-0.41	0.084	-0.978
Yucatán		1.2	-1.47	0.48	-0.80	0.58	1.043	-0.22	0.28	-0.59	0.02
Zacatecas	Hidalgo			1.05	-1.24	0.74	0.13	-0.25	0.93	-0.49	-0.37
	Jalisco										

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Women										
Mexican Republic	1.82	-1.65	0.57	0.02	-0.32	1.19	-0.56	-0.63	0.43	-0.88	4.04
Aguascalientes	1.10	-1.06	0.63	0.19	-0.29	0.84	-0.43	-0.48	0.16	-0.67	2.93
Baja California	1.60	-1.41	0.53	-0.06	-0.45	0.95	-0.51	-0.44	0.43	-0.64	3.52
Baja California Sur	1.30	-1.30	0.47	0.01	-0.27	1.00	-0.50	-0.39	0.34	-0.66	3.12
Chihuahua	1.4	-1.41	0.50	-0.01	-0.29	1.09	-0.37	-0.44	0.30	-0.82	3.34
Mexico City	2.0	-1.59	0.85	-0.08	-0.55	1.19	-0.62	-0.68	0.40	-0.96	4.47
Durango	1.4	-1.53	0.58	0.04	-0.29	1.06	-0.42	-0.38	0.32	-0.81	3.44
Guanajuato	1.7	-1.57	0.58	0.07	-0.25	1.09	-0.56	-0.60	0.38	-0.89	3.88
Warrior	2.7	-2.25	0.37	-0.16	-0.44	1.85	-0.81	-0.91	0.63	-1.03	5.60
Jalisco	1.3	-1.28	0.63	0.06	-0.32	0.97	-0.46	-0.47	0.26	-0.75	3.28
State of Mexico	1.6	-1.65	0.75	0.05	-0.32	1.11	-0.54	-0.65	0.47	-0.91	4.07
Michoacán	2.0	-1.90	0.55	-0.02	-0.29	1.34	-0.56	-0.65	0.57	-1.05	4.47
Morelos	1.8	-1.74	0.63	0.02	-0.29	1.23	-0.62	-0.75	0.54	-0.86	4.26
Nayarit	1.3	-1.24	0.39	-0.03	-0.27	0.98	-0.45	-0.40	-0.58	-0.76	3.02
Campeche	1.3	-1.27	0.39	-0.07	-0.38	0.98	-0.45	-0.41	-0.43	-0.72	3.16
Nuevo León	1.3	-1.27	0.39	-0.07	-0.38	0.98	-0.45	-0.41	-0.43	-0.72	3.16
Coahuila	2.6	-2.18	0.43	-0.07	-0.42	0.17	-0.28	-0.27	-0.54	-0.64	3.46
Oaxaca	2.6	-2.18	0.43	-0.07	-0.42	0.17	-0.28	-0.27	-0.54	-0.64	3.46
Colima	2.6	-2.18	0.43	-0.07	-0.42	0.17	-0.28	-0.27	-0.54	-0.64	3.46
Puebla	2.6	-2.18	0.43	-0.07	-0.42	0.17	-0.28	-0.27	-0.54	-0.64	3.46
Chiapas	2.6	-2.18	0.43	-0.07	-0.42	0.17	-0.28	-0.27	-0.54	-0.64	3.46
Quintana Roo	1.84	-1.56	0.58	-0.01	-0.39	0.99	-0.55	-0.62	0.43	-0.72	3.84
San Luis Potosí	1.4	-1.43	0.60	0.19	-0.18	1.14	-0.55	-0.64	0.20	-0.80	3.60
Sinaloa	1.4	-1.28	0.37	0.07	-0.27	0.88	-0.50	-0.48	0.35	-0.60	3.14
Sonora	1.2	-1.28	0.48	0.09	-0.29	0.90	-0.41	-0.40	0.28	-0.59	2.96
Tabasco	2.2	-2.10	0.44	0.02	-0.31	1.35	-0.62	-0.76	0.65	-0.95	4.74
Tamaulipas	1.4	-1.36	0.51	0.08	-0.38	1.06	-0.45	-0.49	0.31	-0.75	3.43
Tlaxcala	1.8	-1.87	0.66	-0.04	-0.18	1.22	-0.61	-0.73	0.61	-0.91	4.34
Veracruz	1.8	-1.80	0.43	0.06	-0.20	1.30	-0.56	-0.69	0.43	-0.85	4.10
Yucatán	1.9	-1.37	0.41	0.00	-0.33	0.95	-0.51	-0.58	0.35	-0.85	3.64
Zacatecas	1.4	-1.54	0.43	0.05	-0.30	1.05	-0.30	-0.40	0.36	-0.78	3.32

THE
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Note: The age range considered is 3-102 years.

Source: Derived from the II Population and Housing Census 2005.

Federal entity	Digit										Myers Index			
	0	1	2	3	4	5	6	7	8	9				
	Men													
Mexican Republic	1.62	-1.68	0.45	-0.28	-0.31	0.54	-0.21	-0.19	0.56	-0.51	3.18			
Aguascalientes	0.92	-1.14	0.24	-0.19	-0.21	0.38	-0.04	-0.03	0.33	-0.25	1.86			
Baja California	1.48	-1.42	0.56	-0.18	-0.44	0.46	-0.34	-0.22	0.54	-0.44	3.04			
Chiapas	2.5	-2.38	0.34	-0.55	-0.10	0.89	-0.42	-0.42	0.90	-0.84	4.72			
Chihuahua	1.5	-1.53	0.51	-0.34	-0.41	0.49	-0.23	-0.15	0.55	-0.49	3.14			
Mexico City	1.8	-1.70	0.60	-0.37	-0.48	0.63	-0.21	-0.27	0.63	-0.66	3.68			
State of Mexico	1.6	-1.70	0.52	-0.31	-0.39	0.49	-0.17	-0.17	0.66	-0.52	3.26			
Michoacán	1.7	-1.85	0.50	-0.25	-0.25	0.60	-0.17	-0.23	0.56	-0.64	3.39			
Morelos	1.6	-1.81	0.41	-0.31	-0.26	0.50	-0.10	-0.14	0.53	-0.51	3.13			
Nayarit	1.1	-1.28	0.45	-0.28	-0.19	0.41	-0.04	-0.15	0.25	-0.29	2.23			
Nuevo León	1.5	-1.23	0.44	-0.18	-0.52	0.41	-0.35	-0.18	0.44	-0.37	2.83			
Oaxaca	2.0	-2.16	0.29	-0.33	-0.23	0.83	-0.23	-0.23	0.65	-0.63	3.82			
Puebla	1.7	-1.94	0.42	-0.38	-0.31	0.65	-0.18	-0.21	0.73	-0.54	3.57			
Querétaro	1.3	-1.57	0.40	-0.23	-0.32	0.52	-0.15	-0.03	0.47	-0.42	2.72			
Quintana Roo	Baja California Sur	1.32	-1.42	-0.36	-0.23	-0.33	-0.21	-0.22	-0.08	0.56	-0.37	2.66		
	Campeche	1.5	-1.55	0.35	-0.34	-0.48	-0.21	-0.07	-0.31	-0.19	0.48	-0.32	2.38	
San Luis Potosí	Coahuila	1.2	-1.41	0.52	-0.16	-0.26	0.46	-0.18	0.44	-0.68	0.54	-0.41	2.44	
Sinaloa	Colima	1.0	-1.28	0.41	-0.09	-0.21	0.26	-0.23	-0.10	0.46	-0.29	2.21		
Sonora		2.0	-2.19	0.44	-0.29	-0.27	0.61	-0.32	-0.18	0.82	-0.64	3.89		
Tabasco		1.5	-1.48	0.43	-0.15	-0.33	0.56	-0.25	-0.26	0.39	-0.42	2.89		
Tamaulipas		1.6	-1.85	0.40	-0.29	-0.25	0.60	-0.18	-0.18	0.61	-0.53	0.49	-0.48	3.00
Tlaxcala	Durango	1.7	-1.87	0.36	-0.32	-0.24	0.43	-0.15	-0.19	0.66	-0.40	0.40	-0.49	2.80
Veracruz	Guangjuato	1.5	-1.63	0.41	-0.22	-0.33	0.40	-0.25	-0.19	0.47	-0.47	0.41	-0.86	4.37
Yucatán	Warrior	1.3	-1.51	0.40	-0.18	-0.30	0.53	-0.15	0.62	0.25	0.51	0.56	-0.54	3.08
Zacatecas	Hidalgo													
	Jalisco		1.15	-1.30	0.49	-0.20	-0.32	0.37	-0.17	-0.11	0.43	-0.35	244	

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Women										
Mexican Republic	1.68	-1.68	0.39	-0.22	-0.21	0.57	-0.18	-0.32	0.44	-0.47	3.08
Aguascalientes	1.12	-1.31	0.35	-0.17	-0.11	0.42	-0.05	-0.14	0.18	-0.28	2.06
Baja California	1.53	-1.41	0.46	-0.14	-0.34	0.46	-0.23	-0.30	0.42	-0.44	2.87
Baja California Sur	1.27	-1.30	0.32	-0.17	-0.18	0.29	-0.10	-0.10	0.29	-0.32	2.17
Chihuahua	1.5	-1.50	0.41	-0.29	-0.32	0.56	-0.14	-0.26	0.45	-0.48	2.99
Mexico City	1.9	-1.77	0.59	-0.32	-0.39	0.70	-0.16	-0.39	0.48	-0.68	3.71
Durango	1.4	-1.48	0.54	-0.20	-0.07	0.47	-0.18	-0.32	0.29	-0.52	2.77
Guanajuato	1.5	-1.62	0.44	-0.12	-0.13	0.50	-0.17	-0.30	0.34	-0.49	2.83
Warrior	2.4	-2.20	0.25	-0.37	-0.14	1.02	-0.35	-0.50	0.60	-0.71	4.28
Jalisco	1.3	-1.28	0.44	-0.18	-0.24	0.45	-0.12	-0.27	0.28	-0.39	2.48
State of Mexico	1.6	-1.70	0.44	-0.29	-0.27	0.52	-0.12	-0.27	0.52	-0.49	3.13
Michoacán	1.8	-1.83	0.54	-0.12	-0.18	0.58	-0.23	-0.44	0.39	-0.55	3.35
Morelos	1.6	-1.79	0.50	-0.21	-0.21	0.64	-0.12	-0.33	0.36	-0.47	3.12
Nayarit	1.1	-1.19	0.32	-0.23	-0.26	0.26	-0.23	-0.42	-0.24	-0.28	3.18
Nuevo León	1.6	-1.23	0.39	-0.19	-0.15	0.45	-0.16	-0.29	-0.13	-0.40	3.75
Oaxaca	2.1	-2.14	0.33	-0.20	-0.15	0.45	-0.09	-0.23	-0.13	-0.35	2.74
Puebla	1.8	-1.83	0.36	-0.24	-0.12	0.40	-0.03	-0.32	-0.39	-0.49	3.77
Quintana Roo	1.77	-1.79	0.38	-0.19	-0.31	0.66	-0.22	-0.28	0.55	-0.57	3.36
San Luis Potosí	1.3	-1.55	0.33	-0.14	-0.11	0.52	-0.10	-0.16	0.29	-0.41	2.47
Sinaloa	1.3	-1.35	0.37	-0.19	-0.17	0.47	-0.09	-0.40	0.33	-0.32	2.52
Sonora	1.1	-1.17	0.30	-0.07	-0.14	0.26	-0.16	-0.16	0.31	-0.29	2.00
Tabasco	1.8	-2.15	0.32	-0.19	-0.18	0.66	-0.26	-0.23	0.62	-0.45	3.47
Tamaulipas	1.5	-1.46	0.40	-0.12	-0.27	0.49	-0.18	-0.31	0.26	-0.37	2.69
Tlaxcala	1.6	-1.85	0.44	-0.24	-0.14	0.61	-0.06	-0.39	0.51	-0.53	3.21
Veracruz	1.7	-1.82	0.35	-0.23	-0.15	0.47	-0.17	-0.33	0.49	-0.32	3.02
Yucatán	1.4	-1.57	0.27	-0.08	-0.19	0.57	-0.12	-0.14	0.23	-0.43	2.53
Zacatecas	1.4	-1.43	0.46	0.02	-0.03	0.39	-0.15	-0.36	0.24	-0.55	2.53

THE
POPULATION
TRENDS
SURVEY
ED

Note: The age range considered is 3-102 years.

Source: Derived from the 2010 Population and Housing Census.

Federal entity	Digit										Myers Index
	0	1	2	3	4	5	6	7	8	9	
	Men										
Mexican Republic	1.57	-1.52	0.78	-0.20	0.15	0.59	-0.64	-0.37	0.45	-0.81	3.55
Aguascalientes	0.64	-1.17	0.91	-0.03	0.57	0.59	-0.45	-0.47	0.16	-0.75	2.88
Baja California	1.63	-1.45	0.73	-0.03	0.18	0.26	-0.55	-0.44	0.52	-0.84	3.32
Chiapas	2.04	-2.13	0.64	-0.33	0.29	0.90	-0.73	-0.46	0.76	-1.00	4.64
Chihuahua	1.36	-1.34	0.58	-0.29	0.24	0.51	-0.37	-0.18	0.30	-0.81	2.99
Mexico City	2.52	-1.72	1.00	-0.38	-0.22	0.86	-0.92	-0.56	0.49	-1.08	4.88
State of Mexico	1.9	-1.71	0.95	-0.28	-0.10	0.81	-0.70	-0.57	0.58	-0.93	4.30
Michoacán	1.5	-1.57	0.73	-0.16	0.29	0.53	-0.58	-0.34	0.49	-0.93	3.59
Morelos	1.6	-1.56	0.94	-0.33	0.18	0.49	-0.56	-0.32	0.41	-0.91	3.68
Nayarit	1.1	-0.86	0.37	-0.45	0.04	0.04	-0.47	-0.17	0.72	-0.36	2.30
Nuevo León	1.2	-1.28	0.66	0.04	0.21	0.46	-0.50	-0.31	0.22	-0.76	2.84
Oaxaca	1.6	-1.75	0.61	-0.11	0.45	0.56	-0.73	-0.33	0.60	-0.97	3.89
Puebla	1.6	-1.66	0.75	-0.28	0.36	0.77	-0.65	-0.56	0.39	-0.77	3.92
Querétaro	1.1	-1.21	1.01	-0.14	0.12	0.49	-0.62	-0.15	0.16	-0.85	2.87
Baja California Sur	1.0	-1.29	1.01	-0.14	0.12	0.49	-0.62	-0.15	0.16	-0.85	2.87
Quintana Roo	1.0	-1.29	1.01	-0.14	0.12	0.49	-0.62	-0.15	0.16	-0.85	2.87
Campeche	1.0	-1.29	1.01	-0.14	0.12	0.49	-0.62	-0.15	0.16	-0.85	2.87
San Luis Potosí	1.0	-1.28	0.94	-0.29	0.60	0.48	-0.93	-0.44	0.52	-0.28	3.25
Coahuila	0.9	-1.28	0.94	-0.29	0.60	0.48	-0.93	-0.44	0.52	-0.28	3.25
Sinaloa	0.9	-1.28	0.94	-0.29	0.60	0.48	-0.93	-0.44	0.52	-0.28	3.25
Colima	0.8	-1.21	0.72	-0.08	0.22	0.69	-0.43	-0.16	0.15	-0.68	2.58
Sonora	0.8	-1.21	0.72	-0.08	0.22	0.69	-0.43	-0.16	0.15	-0.68	2.58
Tabasco	1.8	-1.97	0.62	-0.15	0.34	0.56	-0.77	-0.28	0.71	-0.90	4.06
Tamaulipas	1.3	-1.42	0.47	-0.38	0.30	0.67	-0.45	-0.17	0.50	-0.83	3.25
Tlaxcala	1.3	-1.42	0.47	-0.38	0.30	0.67	-0.45	-0.17	0.50	-0.83	3.25
Durango	1.4	-1.62	0.76	-0.09	0.81	0.53	-0.67	-0.35	0.47	-0.80	3.53
Veracruz	1.4	-1.62	0.76	-0.09	0.81	0.53	-0.67	-0.35	0.47	-0.80	3.53
Guangjuato	1.5	-1.27	0.78	-0.24	0.43	0.28	-0.61	0.01	0.67	-0.89	2.92
Warrior	1.5	-1.27	0.78	-0.24	0.43	0.28	-0.61	0.01	0.67	-0.89	2.92
Yucatán	1.0	-1.21	0.78	-0.17	0.03	0.51	-0.42	0.34	0.24	-0.40	2.62
Zacatecas	1.0	-1.21	0.78	-0.17	0.03	0.51	-0.42	0.34	0.24	-0.40	2.62
Hidalgo	1.0	-1.21	0.78	-0.17	0.03	0.51	-0.42	0.34	0.24	-0.40	2.62
Jalisco	1.0	-1.21	0.78	-0.17	0.03	0.51	-0.42	0.34	0.24	-0.40	2.62

Federal entity	Digit										Mvers Index
	0	1	2	3	4	5	6	7	8	9	
	Women										
Mexican Republic	1.66	-1.54	0.65	-0.19	0.15	0.65	-0.53	-0.48	0.36	-0.73	3.48
Aguascalientes	1.19	-0.81	0.61	-0.14	0.25	0.22	-0.57	-0.38	0.20	-0.57	2.47
Baja California	1.61	-1.42	0.67	0.08	-0.31	0.35	-0.52	-0.28	0.34	-0.50	3.05
Baja California Sur	0.44	-0.81	0.41	-0.28	0.37	0.22	0.01	0.01	0.28	-0.65	1.74
Chihuahua	1.4	-1.39	0.50	-0.18	0.16	0.53	-0.34	-0.32	0.26	-0.63	2.85
Mexico City	2.5	-1.62	0.86	-0.41	-0.21	0.89	-0.77	-0.75	0.50	-1.08	4.84
Durango	1.1	-1.30	0.32	0.10	0.37	0.45	-0.28	-0.30	0.24	-0.74	2.61
Guanajuato	1.5	-1.51	0.65	-0.16	0.20	0.59	-0.52	-0.44	0.28	-0.59	3.21
Warrior	2.0	-2.00	0.51	-0.22	0.24	0.94	-0.70	-0.66	0.59	-0.71	4.29
Jalisco	1.4	-1.35	0.70	-0.14	0.16	0.54	-0.47	-0.50	0.20	-0.55	3.00
State of Mexico	2.1	-1.69	0.83	-0.30	-0.05	0.79	-0.62	-0.60	0.38	-0.88	4.13
Michoacán	1.4	-1.60	0.64	-0.16	0.14	0.81	-0.40	-0.35	0.30	-0.78	3.30
Morelos	1.5	-1.56	0.79	-0.28	0.06	0.62	-0.49	-0.23	0.36	-0.82	3.37
Nayarit	1.1	-1.39	0.70	-0.31	0.09	0.37	-0.13	0.05	-0.57	-0.76	2.27
Campeche	1.3	-1.30	0.52	-0.25	0.62	0.65	-0.29	0.10	-0.39	-0.60	3.24
Nuevo León	1.7	-1.85	0.54	-0.30	0.53	0.80	-0.26	0.16	-0.42	-0.57	3.96
Coahuila	1.6	-1.72	0.54	-0.26	0.37	0.23	0.25	0.65	0.63	0.76	2.84
Oaxaca	1.7	-1.85	0.54	-0.30	0.53	0.80	-0.26	0.16	-0.42	-0.57	3.96
Puebla	1.6	-1.72	0.54	-0.26	0.37	0.23	0.25	0.65	0.63	0.76	2.84
Chiapas	1.6	-1.72	0.54	-0.26	0.37	0.23	0.25	0.65	0.63	0.76	2.84
Quintana Roo	1.57	-1.60	0.58	-0.19	0.26	0.59	-0.72	-0.33	0.42	-0.56	3.41
San Luis Potosí	1.3	-1.27	0.52	-0.13	0.33	0.35	-0.45	-0.38	0.29	-0.64	2.87
Sinaloa	1.1	-0.98	0.64	-0.07	0.21	0.15	-0.31	-0.49	0.12	-0.42	2.26
Sonora	1.0	-1.17	0.37	-0.05	0.19	0.61	-0.41	-0.42	0.28	-0.41	2.45
Tabasco	1.8	-1.75	0.64	-0.66	0.22	0.86	-0.51	-0.60	0.62	-0.71	4.22
Tamaulipas	1.4	-1.21	0.60	-0.45	0.03	0.59	-0.26	-0.34	0.26	-0.65	2.91
Tlaxcala	1.6	-1.61	0.71	-0.12	0.22	0.34	-0.28	-0.69	0.45	-0.70	3.41
Veracruz	1.3	-1.63	0.71	-0.17	0.38	0.65	-0.59	-0.46	0.48	-0.75	3.60
Yucatán	1.3	-1.23	0.51	-0.15	0.18	0.52	-0.50	-0.21	0.09	-0.59	2.69
Zacatecas	1.0	-1.50	0.55	-0.20	0.27	0.43	-0.27	-0.15	0.57	-0.74	2.86

THE
POPULATION
SURVEY
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Note: The age range considered is 3-102 years.

Source: Derived from the 2015 Intercensal Survey.

Part I. The national population

2. National mortality

In Mexico there is a widespread belief that mortality has been evolving smoothly since the end of the armed struggle of the Revolution (1910-1921), a belief mainly due to the fact that most levels have been quantified every ten years, coinciding with the censuses, or for each of the two five-year periods between censuses; there are really few—almost nonexistent—measurements calculated for each year of the post-revolutionary period.

Even in the early 1970s, when quantifying the levels of the phenomenon, it was accepted that the quality among the different sources of demographic statistics in the country was the same, so mortality levels continued to be calculated using techniques designed for countries whose population data are of proven quality.

The emergence of indirect methods in the mid-1960s (Brass and Coale, 1968) and their progressive improvement (Sullivan, 1972; Trussell, 1975; United Nations, 1983; among others), along with information gathered from pregnancy and birth records in sample surveys conducted in the country for several decades, revealed a serious underestimation of mortality levels in the first years of life in Mexico when calculated using registered births and deaths. Although the most recent estimates of mortality levels and trends in Mexico have incorporated corrections for the first five years of life, the assumption of the same quality in registered deaths and in the populations surveyed to determine levels from five years of age onward persists (for example, Camposortega, 1992: 320-323).

The objective of this chapter is to obtain estimates of mortality levels and trends in Mexico by age, sex, and for each year of the period 1950–2015. The procedures used to estimate mortality levels from 1950 to 2015 are briefly described, with particular attention paid to eliminating biases introduced by misreporting of age and the differing coverage of deaths in vital statistics and population censuses. Data sources, their deficiencies, and the methods for correcting them differ for mortality before and after five years of age; therefore, estimates are made separately for these two age groups.

At all times we assume that, in Mexico, the life limit is 110 years, that is, that nobody reaches their 110th anniversary, so we take both deaths and the population with a reported age of 110 years or more as unspecified age.

2.1 Mortality in children under 5 years of age

2.1.1 Infant mortality

Pregnancy and birth histories collected in six demographic sample surveys: *Mexican Fertility Survey* (EMF) of 1976-77; *National Fertility and Health Survey* (ENFES) of 1987 and *National Demographic Dynamics Survey* (ENADID) of 1992, 1997, 2009 and 2014, and the application of indirect methods based on the proportions of deceased children captured in population censuses and in the *National Survey of Prevalence in the Use of Contraceptive Methods* (ENP) of 1979, have made it possible to prove the existence of an underestimation in the levels of infant mortality when calculated only with vital statistics, as can be seen in both panels of graph 2.1. In the application of indirect methods, the West model of Coale and Demeny (1983) was chosen.

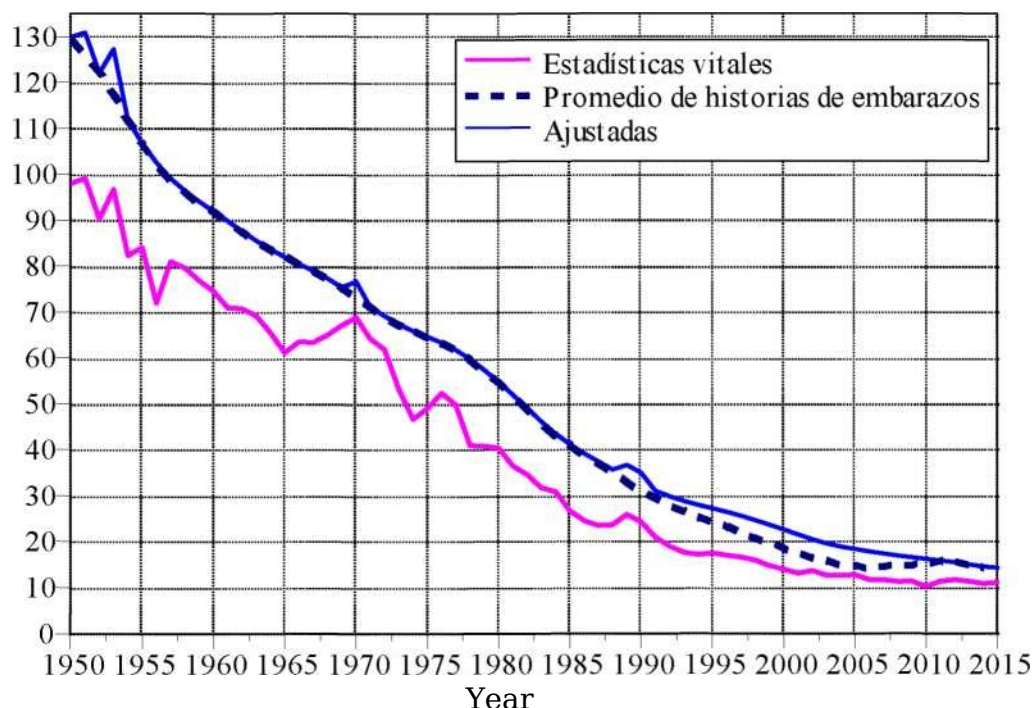
Our estimates give greater weight to those derived from pregnancy histories in the surveys, as well as those obtained through indirect methods, given their undeniably higher quality than vital statistics. We use the latter only as a reference and support. Although measurements by sex can be obtained from the data collected in the seven surveys used, we prefer to work only with mortality for both sexes combined, as the differences could be skewed due to insufficiently large sample sizes. Furthermore, applying indirect methods to census data does not allow for separate estimates by sex. For disaggregation by sex, we adopt the difference in the probabilities of death obtained from vital records, since there is no evidence of distinct underreporting by sex in mortality during the first years of life.

When comparing the different estimates of infant mortality probabilities derived from pregnancy histories in the upper panel of Figure 2.1, the remarkable closeness between the values obtained from these data sources is striking. Generally, older rates, in addition to exhibiting erratic behavior over time, are high and unacceptable, largely due to small sample sizes and the resulting low precision of the estimates.

The lower panel of Figure 2.1 compares the rates derived from vital statistics with those deduced from indirect methods, and from the survival status of the last child born during the year immediately preceding the 2000 and 2010 censuses and the 2015 Intercensal Survey. As a contrast to evaluate the relevance of the indirect estimates, the arithmetic mean of the selected pregnancy histories was taken,¹ and smoothed with the robust *lowess procedure of the* STATA (2003) computer package, using a window of 20% of the observations. In general, indirect assessments agree with pregnancy histories, except for the two most recent estimates from the 1990 census, all those derived from the 2000 and 2010 censuses, the four oldest from the 2015 Intercensal Survey, and the last child from the 1990 census, which clearly overestimate the risk of dying in the first year of life. The closeness of the estimates

¹ The rates for 1952-1961 from ENFES 1987; 1955-1957 from ENADID 1992, 1960-1962 from ENADID 1997, 1970-1976 and 1989-2008 (very low, even lower than those obtained from vital statistics) from ENADID 2009, and 1976-1977 from ENADID 2014 were omitted (see top panel of graph 2.1).

Figure 2.2. Recorded and adjusted infant mortality rates, 1950-2015
(Per thousand live births)



Source: Prepared based on graph 2.1.

The remaining indirect effects, combined with the smoothing of pregnancy histories, led us to select the latter as the definitive one. The increased mortality risks identified in 1951, 1953, 1970, 1989, and 1990 were added to the series; the excess mortality in the first three years extended across the entire age range, while that of the last two years was limited to infant mortality. The results are presented in Figure 2.2.

The separation by sex of the probabilities of dying in the first year of life (q_0) was done using the difference from the probabilities calculated with vital statistics. Let's define the male excess mortality ratio as:

$$n = \frac{E}{PO_1} \sim m, \quad \text{with } PO_1 = \frac{1}{2} \left(\frac{1}{10} + \frac{1}{10} \right)$$

where the superscripts h and m men and women are indicated, respectively. In order to remove some irregularities in the temporal patterns, these were adjusted using the **Lowess** procedure and a window of 80% of the observations. The observed and adjusted trends are reproduced in Figure 2.3.

Assuming a sex ratio at birth of 105 males for every 100 females, the probability of dying in the first year of life for both sexes is:

$$Q_o = \frac{1 - 0.05 \cdot Q}{1 + 2.05} \quad (2.2)$$

Therefore, by introducing equation (2.1) and solving, the female probability is obtained:

$$\frac{2.05q_g}{1 + 1.05p} \quad (2.2')$$

and with it the male one as $q_{ij} = p_a \cdot q^{\wedge}$. In graph 2.4 the final estimates of the infant mortality rate by sex are presented.

2.1.2 Preschool mortality

Figure 2.5 contains estimates of the probability of death in preschool-aged children (1 to 4 years old) using the same data sources as those used for infant mortality.

Assessment using vital statistics was performed by reconstructing cohorts in Lexis diagrams. Births registered for each year were used and separated by sex with a sex ratio at birth of 105. Deaths were separated by birth cohort using the separation factors suggested by Andreev and Kingkade (2015: 376) for the first year of life and the United Nations (1983) separation factors for the four individual preschool ages, which are presented in Appendix D.

If $B(t)$ represents the births registered in year t and $DO(t)$ represents infant deaths, and we equate the infant mortality rate to the probability of dying in the first year of life:

$$\frac{DO(t)}{B(t)}$$

With that value we obtain the separation factors using the Andreev and Kingkade proposal and disaggregate the deaths by cohort as follows:

$$DO(t) = a_o DO_o(t) \text{ and } DO_o(t) = (1 - o_o) DO_o(t)$$

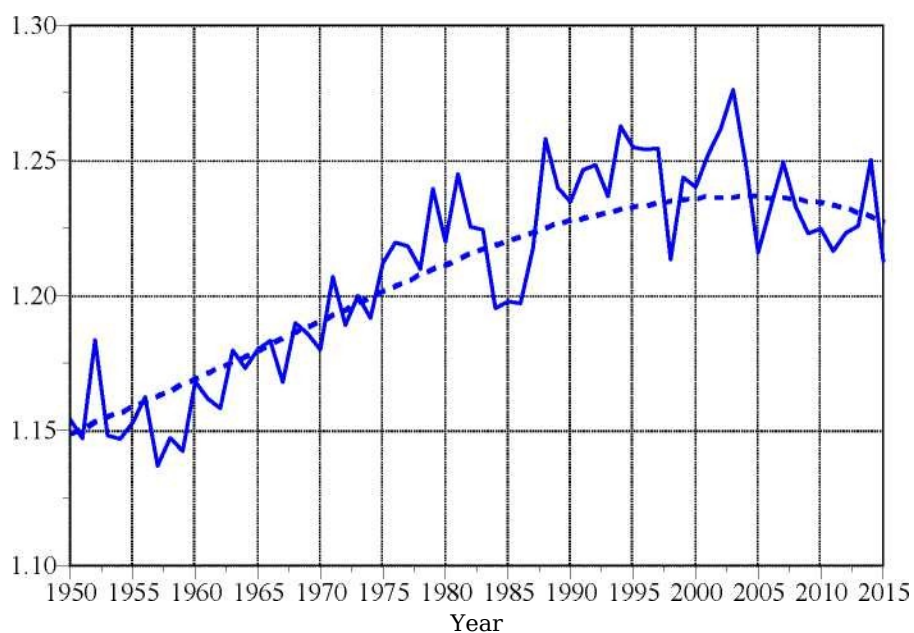
as illustrated in Figure 2.1 for a generic age x . Given the births in year $t - 1$, the number of children under one year old at the beginning of year t is $o(t) = B(t - 1) - DO(t - 1)$ and the probabilities of dying and surviving for the oldest cohort are:

$$9b(i) = J \cdot Po(*) = 1 - \ll, (\ll)$$

for the most recent generation:

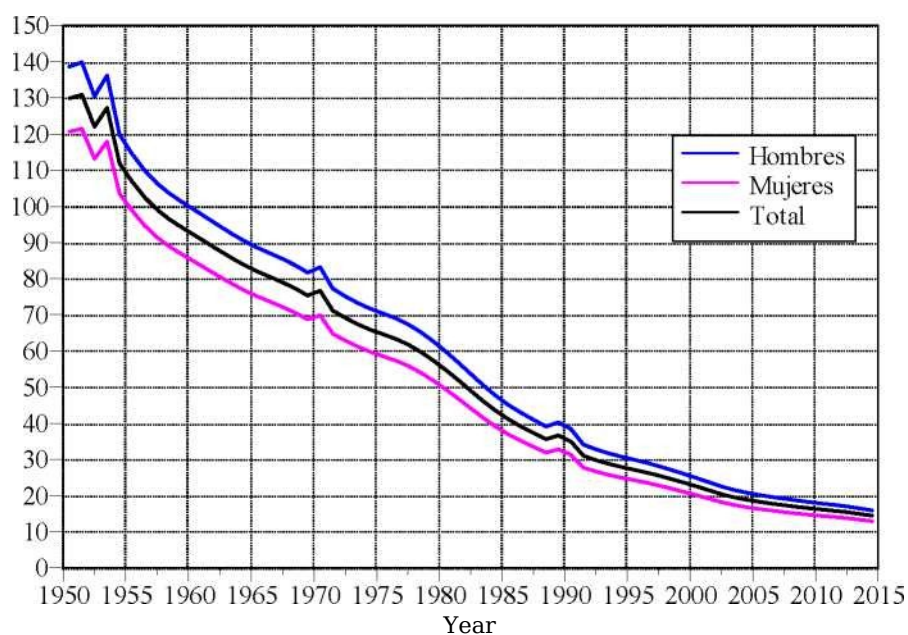
² In both panels of graph 2.5, when calculating the mortality ratios entitled "vital", it They used the total registered births, that is, without distinguishing the year of birth (occurrence), and Registered deaths of children under one year of age. These were separated by cohort using the of separation by Andreev and Kingkade (2015: 376), to construct the Lexis diagrams of figure 2.1.

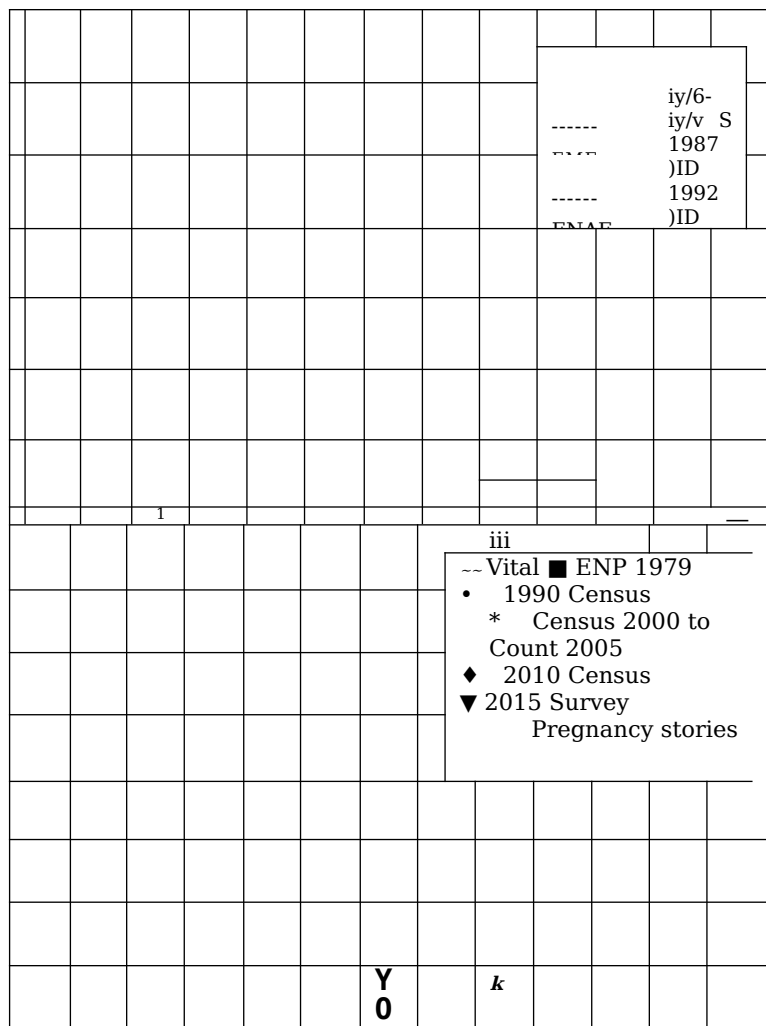
**Figure 2.3. Male infant excess mortality ratio
recorded and adjusted, 1950-2015**



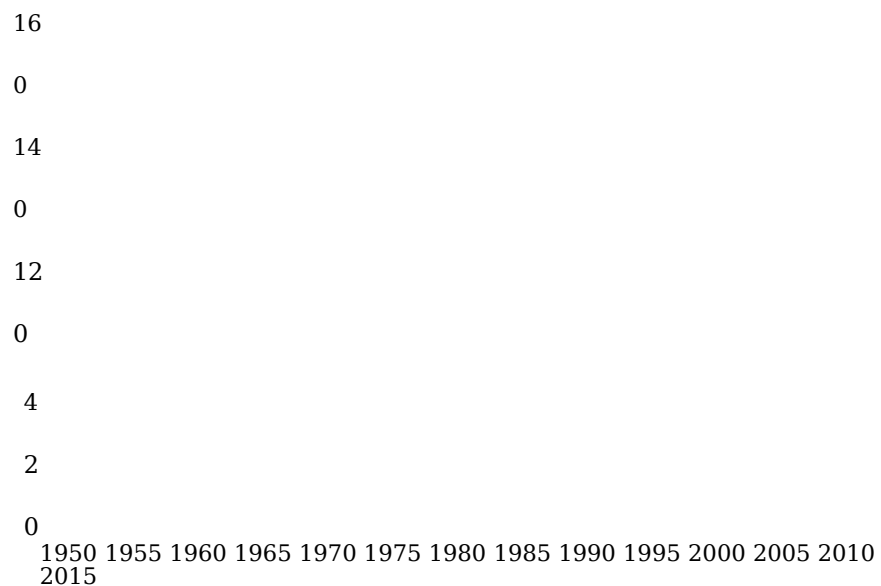
Source: Same as in graph 2.1.

Figure 2.4. Infant mortality rate by sex, 1950-2015
(Per thousand live births)



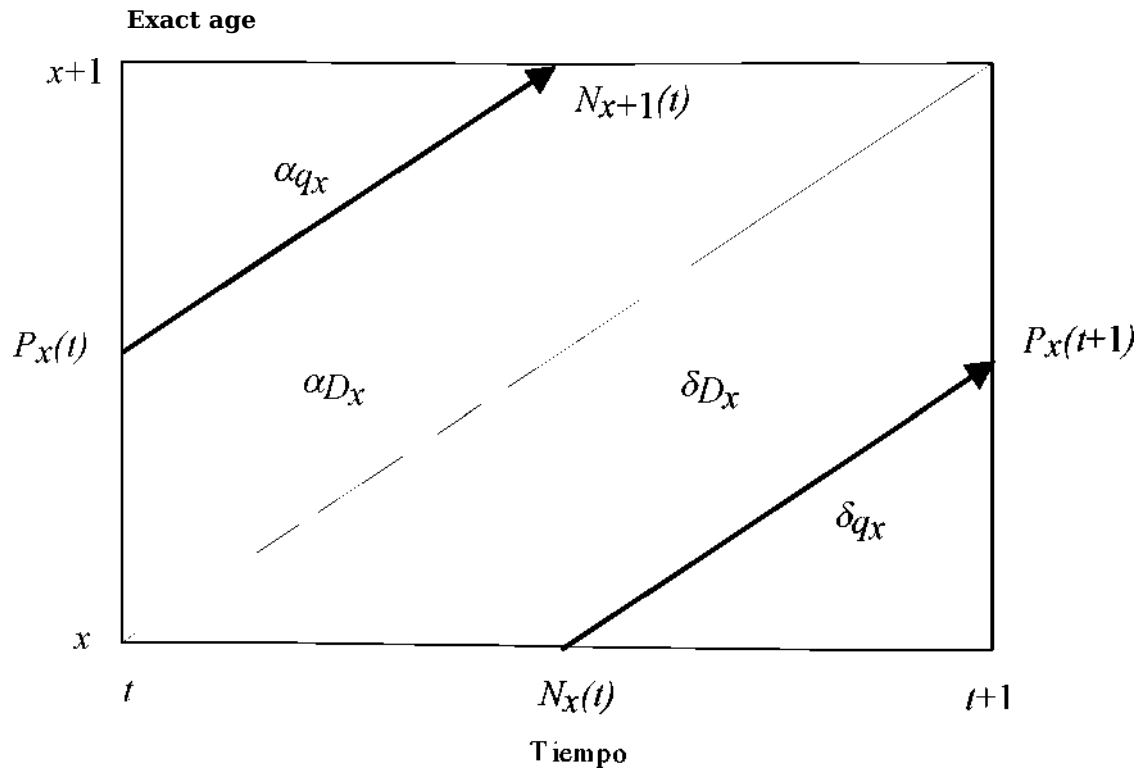


Vital statistics and indirect methods



Source: Estimates based on the EMF 1976-77, ENFES 1987 and ENADID 1992, 1997, 2009 and 2014 surveys; ENP 1979; population censuses 1990, 2000 and 2010; population count 2005; intercensal

Lexis diagram illustrating the calculation of the probabilities of dying for a given age in a given year



$$s_{< t o(t)} = \quad y^s P o(t) = 1 - {}^s q_o(t)$$

and the overall survival and death ratios:

$$P o(t) = {}^a p_o(t) {}^s p_o(t) \quad \text{and} \quad q_b(i) = 1 - p_o(i)$$

The probabilities of dying in the first year of life shown in the graphs 2.1 and 2.2, marked as "vital" were calculated in that way.

If the completed age 0 is replaced by x , and births by the population reaching the x th anniversary during the year $JV_{1+1}(t) = P_{x+1}(t) - {}^o D_x(t)$, the probabilities are obtained survival and death, for individual preschool ages ($x = 1, 2, 3, 4$).

$$\hat{P}_x(t) = {}^a p_x(t) {}^s p_x(t) \quad y \quad q_x = 1 - \hat{p}_x$$

Finally, the probability for the entire age interval is obtained as:

$$\frac{{}_4 g_i(i)}{{}_4 p_4(t)} = 1 - {}_4 P_j(i) = 1 - P! (t) {}_{p2}(t) {}_{p3} \quad (23)$$

The values calculated in this way are those included in both panels of graph 2.5 entitled “vital”.

It is observed that, while indirect estimates using the 1990, 2000, and 2010 censuses—noted for infant mortality—continue to overestimate the level compared to other sources, and the first two estimates from the 1979 National Population Survey (ENP) underestimate it, the values obtained from vital statistics are consistent with other time series, whether from pregnancy histories or indirect methods. The similarity of the probabilities obtained from the different sources is due to the fact that only infant deaths have been found to be underreported in Mexico (for example, Ordorica and Potter, 1981: 25); therefore, the reporting of deaths of one year of age or older should be similar.

Again, we selected the time series derived from the average of pregnancy histories smoothed using **Lowess** with a 20% window of observations, and added the excess mortality of 1951, 1953 and 1970.³

Because mortality in preschool-aged children is numerically small, the sample sizes of pregnancy histories are insufficient to obtain accurate estimates of the probability of dying by age during the preschool stage. Thus, we retained the overall probabilities ${}_4q_1$ and, in accordance with (2.3), adjusted them to the probabilities of individual ages derived from the reconstruction in Lexis diagrams. However, to do this, we performed a new reconstruction in Lexis diagrams.

Births registered by year of occurrence up to the fifth year of life (see Chapter 3 for a more detailed description) from 1972 to 2014 were used; the total number of births registered from 1945 to 1967; and a linear interpolation of the proportion—between 1967 (1.000) and 1972 (0.923)—that births registered by cohort represent of the total number of births registered in the year. The total was separated by sex with a sex ratio at birth of 105. In the first year of life, we used our estimates of infant mortality, where total deaths of children under one year of age for each specific sex were estimated as:

$$D_o(t) = B(t)q_o(t)$$

which were again divided by generation with the separation factors of Andreev and Kingkade and of the United Nations.

In the probabilities of dying for each individual age in the 1-4 year interval, the male excess mortality ratio $p_x = q_x/q^m$ for age x was **smoothed** using the **Lowess algorithm** with a window of 80% of the observations for each of the four ages. The observed and adjusted ratios are presented in Figure 2.6.

Let d_x Deaths of both sexes between the exact ages x and $x + 1$ ($a; = 1, 2, 3, 4$) in the life table. The total number of survivors on anniversary x is:

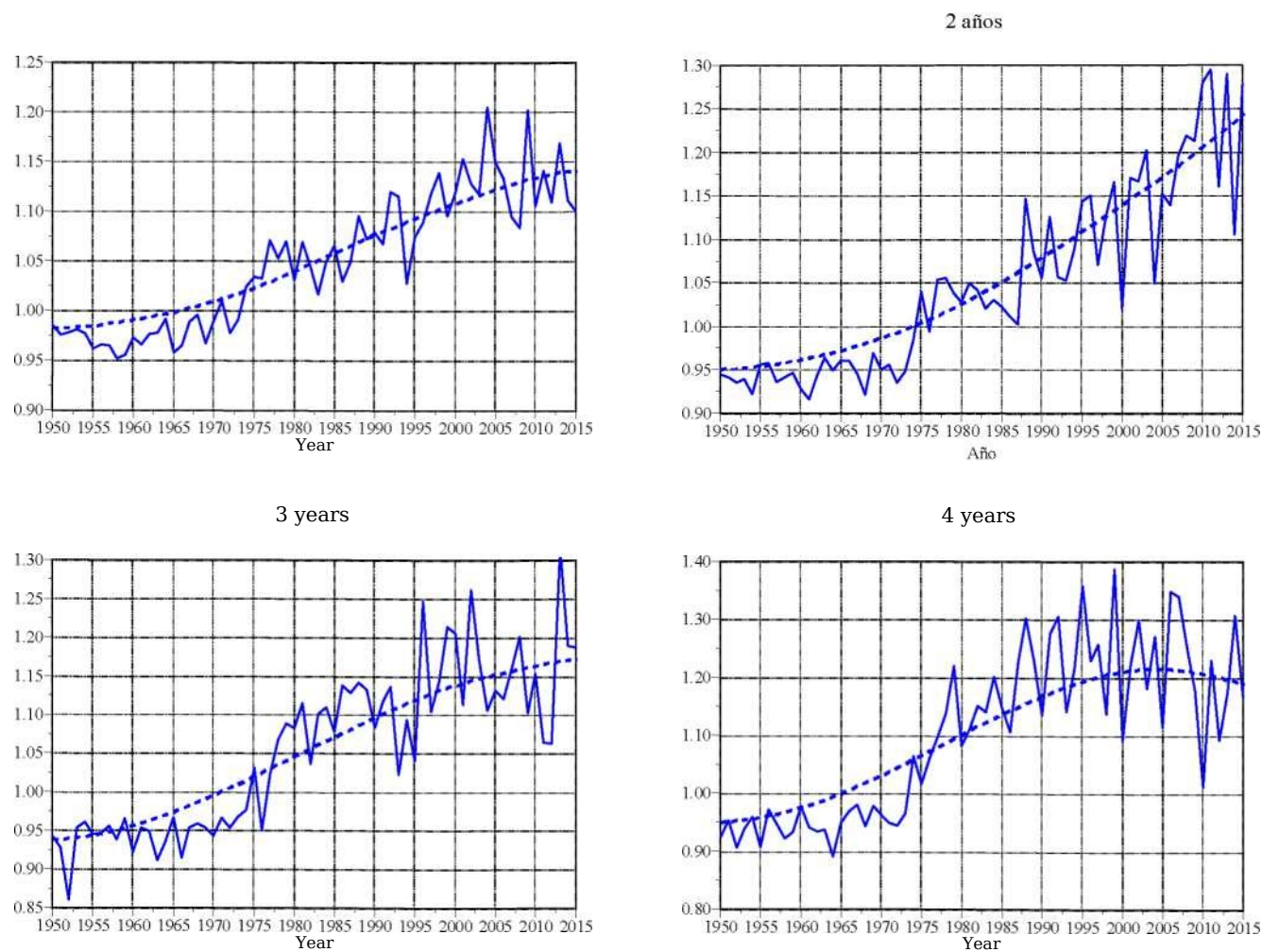
$$pa_{-ph}, pm_{c_x}$$

and the deaths of both sexes of age x are:

$$L_x = L_{x-1} - d_x = L_{x-1} - (p_x L_{x-1} + q_x L_{x-1}) = L_{x-1} (1 - p_x - q_x) = L_{x-1} (1 - p_x - q_x) = L_{x-1} (1 - p_x - q_x)$$

³Various inspections show that the greatest risk of dying in 1989 and 1990 is exclusive to the first year of life.

Figure 2.6. Observed and smoothed ratio of male excess mortality in preschool-aged children, 1950-2015^{-Yo 505}



Source: Population censuses and vital statistics, 1945-2015.

where from,

$$q_x = \frac{d\% (gfe + c)c}{fa_x^{ph} + i_{pm}^{pm}}$$

Given our estimates of q_0 for each sex and $\epsilon_{ij} = 1.05$ we have that $(1 - Q_0) = \epsilon Q_0 (1 - Q_0)$ and $\epsilon = \epsilon Q_0 (1 - Q_0)$. The process starts with $x = 1$ and the value is obtained as:

$$q_x = \frac{(\epsilon f_x + c) i_x}{f_x + i_x}$$

where q^{TM} and p_j are derived from cohort reconstruction in Lexis diagrams. Once the q values are adjusted for sex, they are used to calculate the survivors at exact age 2, and the procedure is repeated until the probability of dying between 4 and 5 years of exact age q_4 is estimated. The time trend of q for each individual age was smoothed using the **Lowess procedure** with a window of 20 % of the observations for each of the four ages. The original and smoothed values are reproduced in Figure 2.7. Solving for q in the previous equation:

$$ix +$$

Let $y_x = \epsilon_x / f^{TM}$ be the proportion of masculinity of the survivors at the exact age x , whereby, by dividing the numerator and denominator of the previous equation by f^{TM} :

$$= (1 + 7a) \epsilon f_x \quad (2.4)$$

$$1 S - \epsilon f_x P_x$$

The probability of male death is obtained directly as $q_x = p_x q_x$. The trend of the probability ϵ , of dying between 1 and 5 years of age for those who survived the first year of life, obtained in this way, is presented in Figure 2.8, and the total probability along with that derived from the smoothed pregnancy histories (lower panel of Figure 2.5) in Figure 2.9. Based on visual inspection of Figure 2.9, we retained the probabilities of the pregnancy histories from 1959 to 1968, from the cohort reconstruction (Figures 2.6 and 2.7) from 1969 to 2014, and for 1950-1958 following the temporal pattern of the cohort reconstruction, starting with the value of the pregnancy histories from 1959, that is:

$$\epsilon_i(t-1) = \epsilon q_i(t) + U q_i(t-1) - \epsilon Q_i(t) \quad t = 1950, 1951, \dots, 1958$$

where the probabilities within the brackets correspond to cohort reconstruction and ϵ (1959) to pregnancy histories.

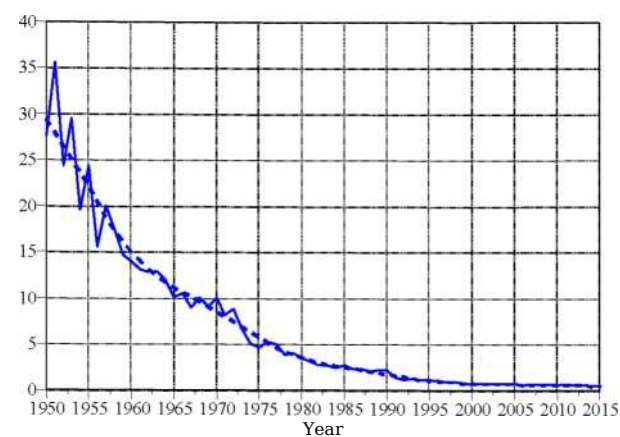
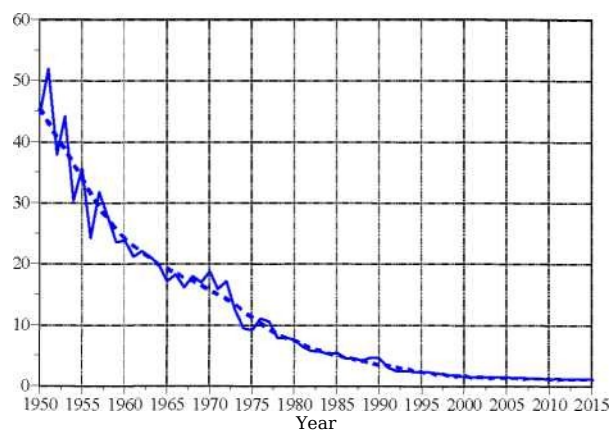
The male excess mortality ratio ϵ_{p1} derived from cohort reconstruction does not require further smoothing, as it retains the age-specific smoothings for the preschool period, as can be seen in Figure 2.10, where it is compared with the ratio that would have been obtained without smoothing the p_x ratios using the Lowess procedure (Figure 2.6). The final estimates by sex are presented in Figure 2.11.

For the years where pregnancy history estimates are used, it is necessary to decompose the probability ϵ_{p1} into the mortality ratios q , $r/2$, q_{-} and ϵ_4 . This was done

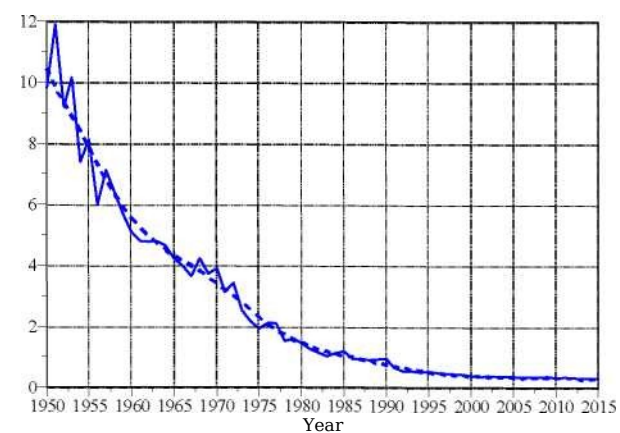
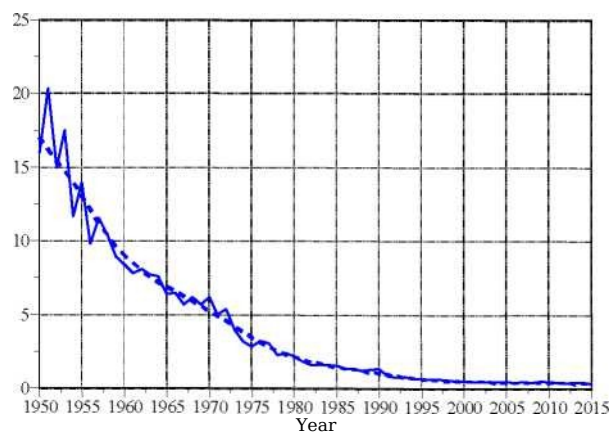
Figure 2.7. Total observed and smoothed probability of death in preschool ages, 1950-2015

(Per thousand)

1 year

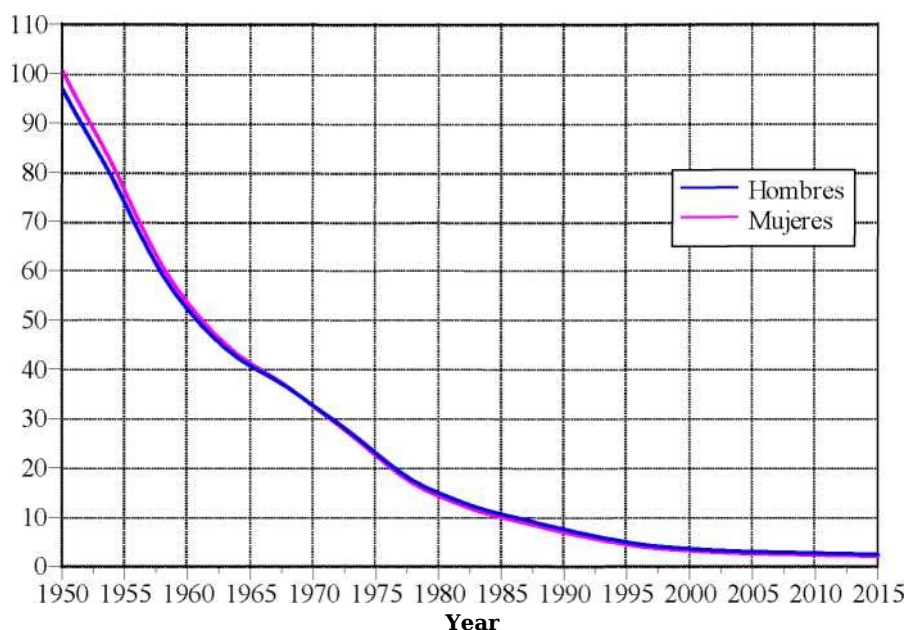


4 years



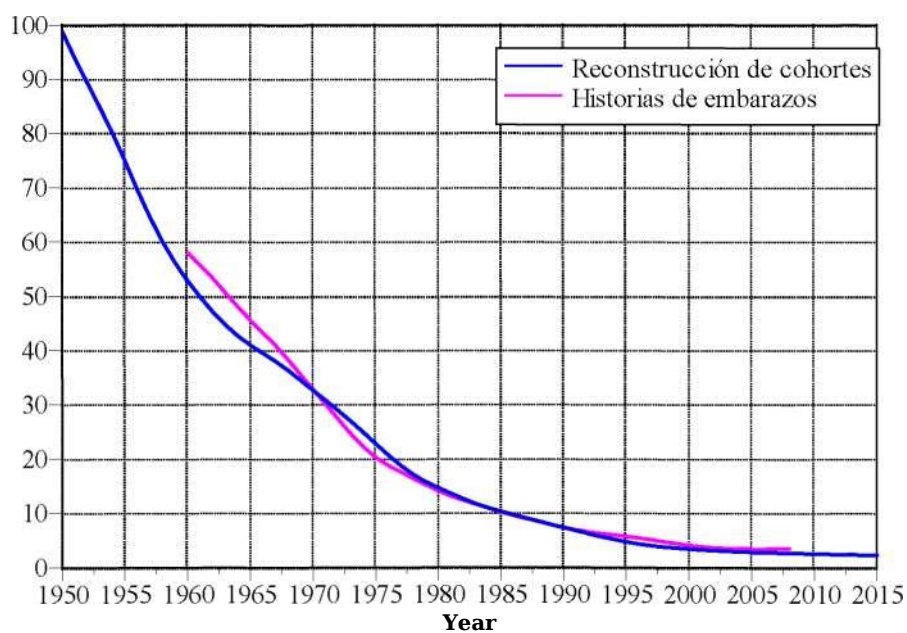
Source: Population censuses and vital statistics, 1945-2015.

Figure 2.8. Probability of preschool mortality by cohort reconstruction by sex, 1950-2015
(Per thousand one-year-old survivors)



Source: Estimates based on vital statistics from 1945 to 2015.

Figure 2.9. Preschool mortality probability from cohort reconstruction and pregnancy histories by sex, 1950-2015



Source: Graphs 2.5, 2.7 and 2.8.

assigning an equal proportional factor for the four ages. If r_i is the survival probability of the cohort reconstruction and ${}_4j5j$ the one adopted for 1950-1968, the fourth root of the quotient is taken:

$$r = \sqrt[4]{\frac{r_i}{{}_4j5j}} \text{ de donde } r = r_i^{1/4} {}_4j5j^{-1/4}$$

and each reconstruction probability p_x is multiplied by that factor:

$$P_x = r p_x \text{ a; } = 1, 2, 3, 4$$

By equation (2.3):

$$f_{>1} \text{ in } V: VA = r^i p_1 p_2 p_3 PA = r^4 / q = {}_4pi$$

and finally:

$$q_x = 1 - p_x = 1 - r p_x \text{ a; } = 1, 2, 3, 4$$

It should be noted that, by excluding international migration from cohort reconstruction, estimates of preschool mortality differ slightly. If there is a migration gain, the population—the denominators of the probabilities—increases and the risk of dying decreases, reaching a maximum of 8.9% during the period considered. Conversely, a migration loss raises the 4g4 ratio by 3.2% or less during 1950–2014.

2.2 Mortality from 5 years of age

Let $D_x(t)$ denote the deaths of people of age x that occurred during year t and were recorded by the civil registry, and $P_x(t)$ denote the population of age x in the middle of year t . Suppose that both have coverage levels $S_x(t)$ and $Tr_x(t)$, respectively, with respect to the actual deaths $D_x(t)$ and the true resident population $P_x(t)$:

$$r_{A)} \sim \frac{D_x(t)}{DS(t)} \text{ (} U \text{) } - P_x(t)$$

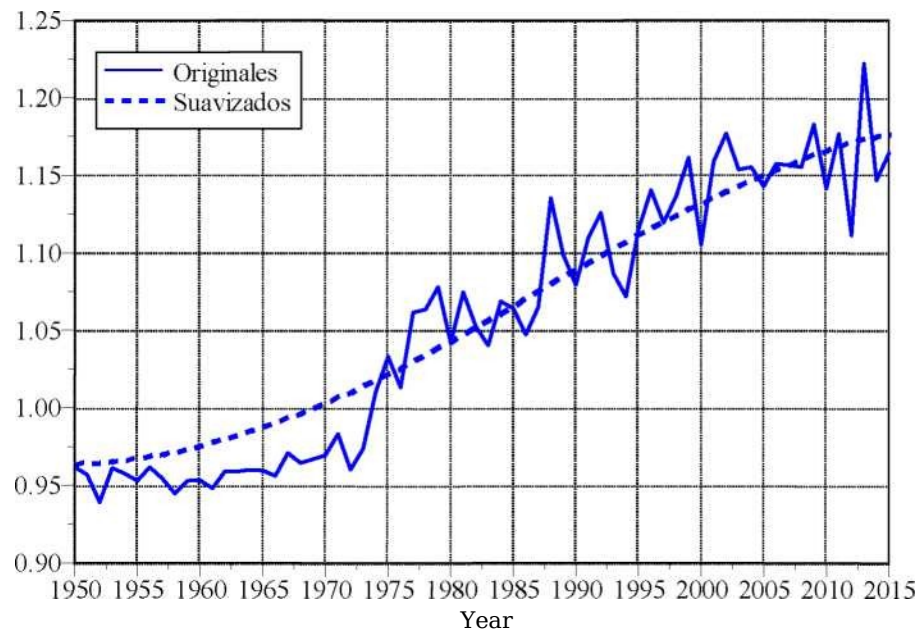
If we introduce these factors into the **actual** mortality rates, we get:

$$\frac{D_x(t)}{P_x(t)} = \frac{D_x(t)/S_x(t)}{P_x(t)/Tr_x(t)} = \frac{Tr_x(t)}{S_x(t)} \frac{D_x(t)}{P_x(t)} \quad (2.5)$$

where $k_x(t) = S_x(t)/Tr_x(t)$ is the relative coverage of deaths with respect to the census population and $M_x(t) = D_x(t) / P_x(t)$ is the recorded mortality rate.

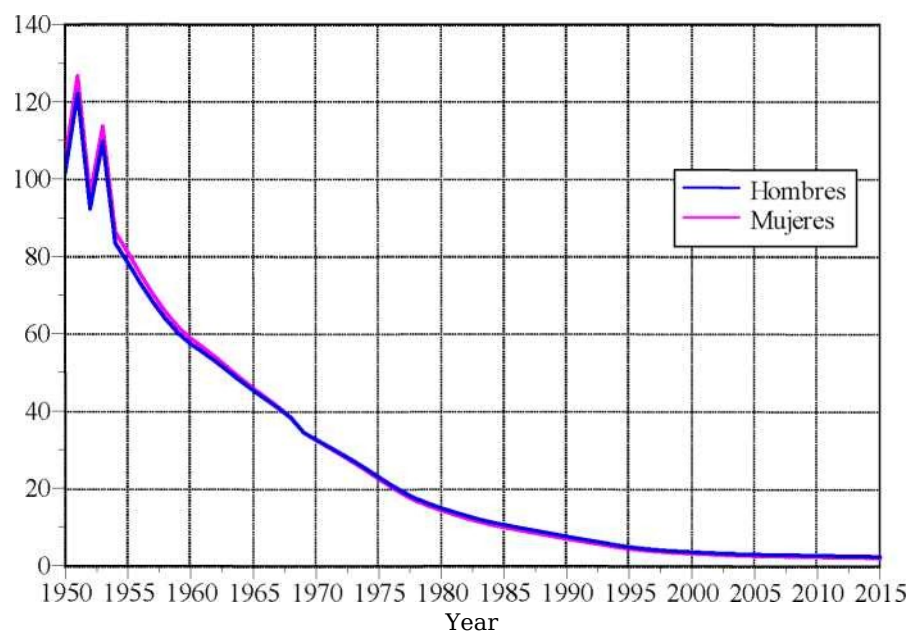
$S_x(t)$ and $Tr_x(t)$ separately, because since the level of mortality is determined more by the level of development achieved in a society—a more egalitarian one with fewer deprivations—and the advancement of medicine, than by the size of the population, both levels of coverage are simultaneously linked. In practice,

Figure 2.10. Global male preschool excess mortality ratios derived from cohort reconstruction with original and smoothed ratios



Source: Estimates based on vital statistics from 1945 to 2015.

Figure 2.11. Estimated probability of preschool mortality by sex, 1950-2015
(Per thousand one-year-old survivors)



Source: Graphs 2.9 and 2.10.

Once the factors $k_x(t)$ **have been determined** by the models described below, and $7v_x(t)$ which results from the demographic reconciliation (chapter 5), where mortality corrected by $k_x(t)$ **intervenes, or** $x(t)$ is obtained directly as the product $S_x(t) = k_x(t) 7r_x(t)$.

Let us consider the relative distributions of population and deaths from age a :

$$dr, a(\wedge) \frac{Px(t)}{Pa+} \text{ and } 0_{xi} a(t) \frac{Dx(t)}{Da+}$$

with

$$\wedge_{x=a}^{u-1} c_{x|a}(t) = 1 \text{ and } \wedge_{x=a}^{0j-1} 2e_{xi} a(t) = 1$$

where u_j is the limit of human life, that is, an extremely advanced age beyond which no one survives (here we adopt 110 years), and $a+$ refers to ages 6 years or more. If we incorporate the age structures of populations and deaths instead of the rate recorded in equation (2.5), we have:

$$1_{-D_{a+}(t) 0_x, q(t)} \quad (2.6)$$

It can be seen that the age pattern of the corrected rate depends almost entirely on the age compositions of deaths and the population, while its level is closely related to the relative coverage of deaths with respect to the census population ($k_x(t)$) and the recorded mortality rate for **ages** a and older ($M_{a+}(t) = D_{a+}(t) / P_{a+}(t)$). If the age distributions of deaths and the population are consistent with each other—say, the age pattern of the recorded rates is adequate—it is reasonable to assume that the relative coverage factor is the same for all ages but different over time, that is, $k_x(t) = k(t)$ for all x . And this factor corrects the mortality rates for each age starting at **age** a .

Before proceeding to apply the methods presented in Annex B to estimate the $k(t)$ factor, let us correct the misreporting of age in civil registry deaths and in census and population count populations.

2.2.1 Correcting the misreporting of age at death

In order to preserve the changes in the age structure of deaths resulting from the temporal modification of the pattern of causes of death, the age composition—by displayed age—of deaths across the country was smoothed using the **Lowess procedure**. Based on a visual inspection of different smoothing methods, the adjustment was made as follows: ¹

1. From 1930 to 1985 with 10% of the observations from 3 to 18 years, 20% from 22 to 109, and geometric interpolation from 19 to 21 years with the smoothed values

- For adjusting the age structure of populations, as will be seen in the following section, a double multiplicative additive model was adopted for the logarithm of smoothed deaths—say $\mathbf{Y}_x(\mathbf{t}) = \mathbf{f}(\mathbf{t})\mathbf{D}_x(\mathbf{t})$ —from 1930 to 2014:

where $\mathbf{a}_x$ corresponds to a standard or typical pattern of the age distribution of deaths over the 85-year period; $\mathbf{A}_t$ relates to the annual number of deaths; $\mathbf{3}^{\wedge}$ expresses the rate of change of the age composition with respect to time (first derivative), which is affected —multiplicatively— by a time trend parameter $\mathbf{B}^{\wedge}$; $\mathbf{3}^{\wedge}$ is the acceleration in the variation of the age structure (second derivative) associated with the time change parameter $\mathbf{B}^{\wedge}$, and $\mathbf{r}_{t-x}$ are the cohort effects, which are associated with the size of the generation born in year $t - x$. The parameters were estimated with a least squares procedure (Wilmoth, 1989), based on the singular value decomposition of the bivariate age and time array of deaths.

$$Y_x(t) = a_x + A_t + f3^{\wedge}BÍ^{1]} + (3^{TM}BP$$
$$e_x(t) = \ln\{D_x(t)\} - Y_x(t)$$

Because time progresses to the right and age downwards, any diagonal represents the history of a particular generation or cohort. For example, deaths at age 30 in 1930 correspond to those born in 1900, those at age 31 in 1931 to the same generation, as well as those who died at age 100 (last row) in 2000. The residuals have been grouped into five categories: dark green cells correspond to the most positive (the recorded deaths greatly exceed those estimated with the additive-double multiplicative model) and light green to the least positive; yellow cells represent residuals close to zero; red cells to very negative residuals (the estimated values greatly exceed those recorded); and orange cells (in Figure 2.13) to the least negative.

It is noted, for example, that the 1900 and 1910 generations must have been very numerous, since in almost every year they significantly exceed those estimated with the

Figure 2.12 Residuals of the applied additive-double multiplicative model

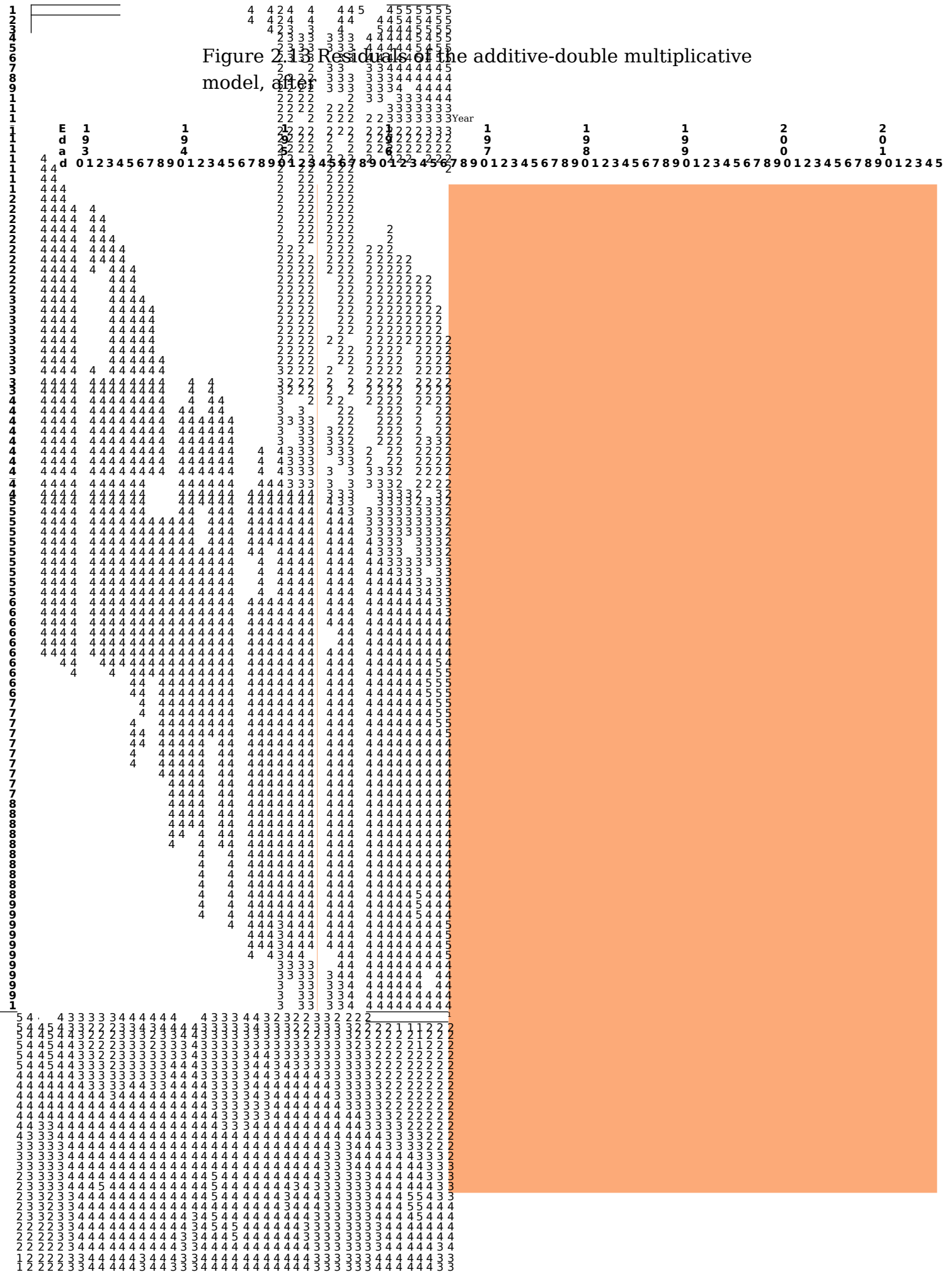
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Figure 2.13 Residuals of the additive-double multiplicative model, after



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Source: Estimates based on vital statistics from 1930 to 2015

model; however, if we move up a bit, we see several generations, born during the Mexican Revolution (1910-1921), with markedly negative residuals, indicating that the cohorts originating from the years of the conflict are small compared to the others. The cohort effects for each generation were taken as the simple arithmetic mean of the residuals for each cohort (from each diagonal). Once the cohort effects were estimated, the double-multiplicative additive model was estimated as:

$$\ln \{E_{x,t}\} = \mu + \alpha_x + \beta_t + \gamma_{x,t} \quad (2.7)$$

and with the new residues $\hat{e}_{x,t} = \ln \{D_{x,t}\} - Y_{x,t}$. The cohort effects were re-estimated.

The procedure for estimating (2.7) was performed iteratively until the cohort effects $\gamma_{x,t}$ stabilized. The behavior of the residuals after 25 iterations is reproduced in Figure 2.13.

Model (2.7) was tested with deaths from three age intervals: 1 to 109, 3 to 109, and 5 to 109 years. Given the structure of the death series, for example, in the case of 1 to 109 years, each of the 189 generations involved (1821-2009) can appear from only once (the generation of 1821 when it was 109 years old in 1930 or the generation of 2013 with 1 year old in 2014) to 86 times (the cohorts born from 1896 to 1928).

Figure 2.14 shows a minimal difference between the proportional factors $\exp \{ \gamma_{x,t} \}$ of the three intervals. In order to retain the greatest number of cohort effects, the model involving deaths from 1 to 109 years was adopted.

Model (2.7) was obtained for each sex separately; the temporal trend of the cohort effects is reproduced in Figure 2.15.⁴ A smaller gap is observed in the generations born from 1840 to 1970, and from then on the difference is significant and increases after 2002. In order not to introduce bias into subsequent estimates, we preferred to assume that the cohort effects deduced from the total number of deaths were equal for both sexes. It was deemed advisable to remove some irregularities in the temporal trend, which was done using the **Lowess procedure** and a 5% window of the observations. The original and adjusted values are shown in Figure 2.16.

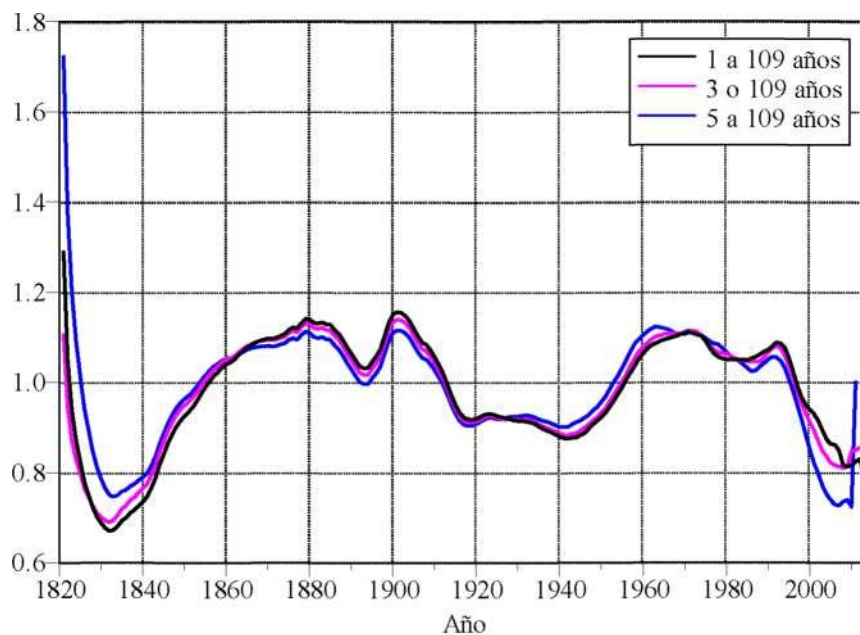
2.2.2 Correcting misreported age in the population

In the populations surveyed in Mexico from 1950 to 2015, a clear preference for the digits 0 and 5 in age reporting is observed (Tables 1.8 to 1.17), and, as with deaths, this deficiency has decreased considerably over the years. If cohort effects were extracted from the twelve census observations (nine decennial censuses from 1930 to 2010, the 1995 and 2005 counts, and the 2015 survey), they would not be reliable, since they would be determined more by age digit preferences than by birth year reporting.

The digit preference in the age reporting of census populations was corrected using Gray's (1987) successive moving average algorithm. The author begins

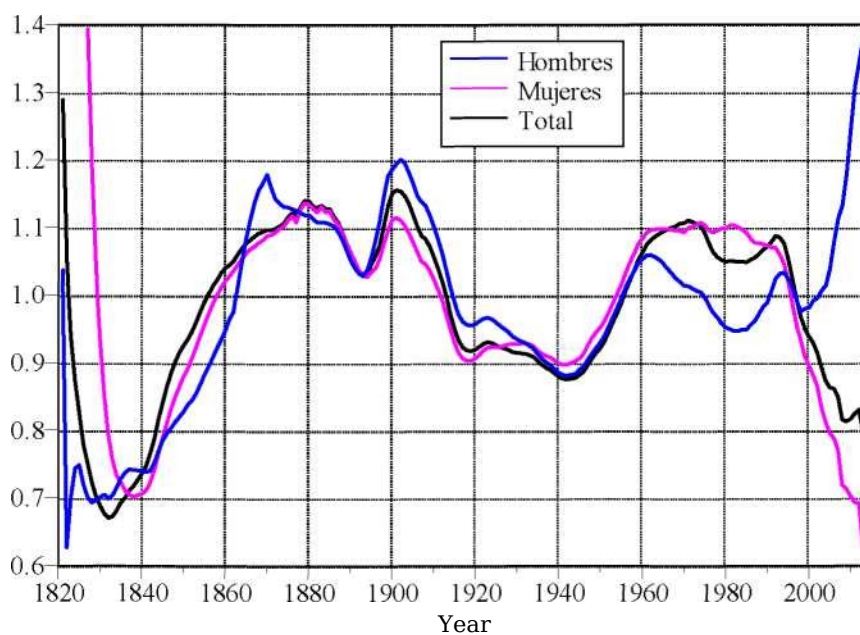
⁴ In order to have greater clarity in the graph, we suppressed the female cohort effects from 1821 to 1826, whose values are: 9,733, 5,455, 3,588, 2,600, 2,016 and 1,617, respectively.

Figure 2.14. Cohort effects for the 1821-2011 generations based on three age intervals of registered



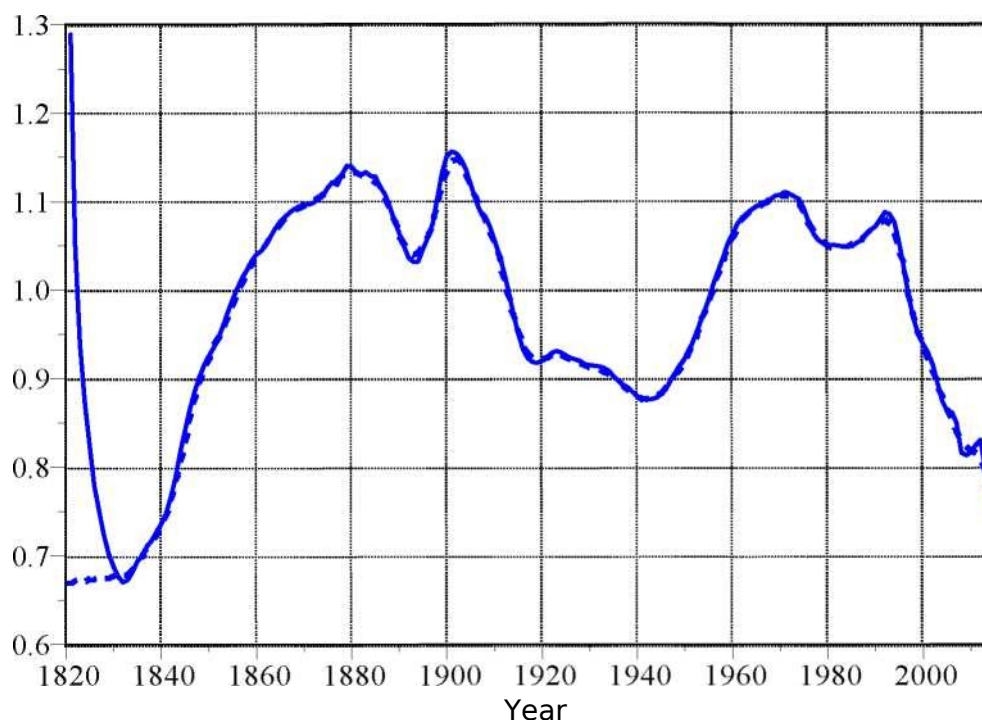
Fuente: Estimaciones con base en las estadísticas vitales de 1930 a 2015.

Figure 2.15. Cohort effects by sex for registered deaths



Source: Estimates based on vital statistics from 1930 to 2015.

Figure 2.16. Original and smoothed cohort effects for registered deaths of one year of age or older, 1820-2015



Source: Estimates based on vital statistics from 1930 to 2015.

The idea is that preference or rejection for a particular age is concentrated in the ten ages around it and the age itself, for example, the interval of 15 to 25 years for the age 20. The author proposes to weight the nine central ages with 1/10 and the two extremes with 1/20, so that the sum of the eleven weights is equal to one.

say S_1 is the moving average of the census populations, S_2 the moving average of the first moving average, S_3 of the second, etc. Gray shows that the operation:

$$Q_k^x = (k + 1)S_k - kS_{k+1} \quad (2.8)$$

It is an unbiased estimator of the population, in the sense that:

$$\hat{Q}_x^2 = \hat{P}_x^2 \quad \text{For } k > 1 \quad (2.9)$$

Applying Gray's algorithm has the restriction that each successive moving average omits the population of ten simple ages. Let's take the entire age range from 0 to 109

$$\hat{y} = \frac{1}{10} \sum_{y=x-4}^{20} \hat{y}_{x+b}$$

It is clear that the first moving average only takes values from age 5 onwards, as it makes no sense to include negative ages when calculating $\hat{S}_{x-4}$ from 0 to 4 years. At the extreme advanced ages, although we can assume that the population is zero from age 110 onwards, in order to avoid very small and even negative values between 100 and 109 years, we prefer an alternative procedure for both the beginning and end of life. Let a_6 and a_z be the first and last ages considered, respectively, and suppose that $\hat{S}_{k-4} = \hat{P}_{b-4}$ and $\hat{S}_{i-4} = \hat{P}_i$, for all k . For ages $a_6 + 1$ to $a_6 + 4$ we take the simple moving average from b to $a_6 + 2$, to $a_6 + 4$, to $a_6 + 6$ and to $a_6 + 8$, respectively, and for ages $a_z - 4$ to $a_z - 1$, the moving average from $z - 8$, from $z - 6$, from $z - 4$ and from $z - 2$ to z , respectively, for each successive value of $\hat{S}_{k-4}$.

The estimate was made for the population aged 3 years and older, since there is evidence that census undercounting of children, well-documented in many countries, is concentrated among children under 3 years of age in Mexico. Thus, we applied Gray's algorithm from 3 (age a_6) to 109 (age a_z) years, incorporating our proposal for the first and last ages. The application was carried out, as mentioned above, up to the fourth successive moving average, that is, $\hat{Q}_x$ in (2.8). The bias is smaller, that is, the difference between both sides of (2.9) is minimal.

The procedure was performed for each federal entity and sex separately, for each census from 1950 to 2010, the 1995 and 2005 counts, and the 2015 survey. Seeking to prevent the adjustment with Gray's procedure from canceling real effects on the age structure of the population surveyed, cohort effects were discounted before applying the algorithm to control for these possible effects; that is, the initial population was taken as $P_x(t)$

$P_x(t)$ and $_{-7}^{i-4}$ were added to the smoothed population, and the resulting population age structure was provided to the total census population aged 3 years or older. Hereafter, we denote populations adjusted in this way by $\hat{P}_x(t)$.

The inclusion of cohort effects rests on the following criterion: true age-specific mortality rates in a given year depend only on the incidence of the phenomenon and not on the size of the generations exposed to the risk. Because it is through these rates that the population and age-specific deaths are related ($D_x(t) = P_x(t) M_x(t)$), it is plausible to assume that the cohort effects extracted from the deaths are the same as those for the population. The total population of the country was obtained as the sum of the residents of the 32 federal entities.

From this point on, we disregard state populations and only consider the national population. Information by state resumes in Chapter 6.

In Annex B, when developing the general growth model, the following equation is obtained

⁵ In the 1930 and 2010 censuses, for example, the census population of 3 and 4 years old (enumerated plus corresponding to pending housing; see chapter 1) is larger than that reconstructed in Lexis diagrams with deaths and international migrants.

⁶ Among men in 2010, for example, the census population aged 3 years or older was 51,717,218 and from the adjustment with (2.8) of 51,689,685, that is, a difference of only 27,533 males, or an 0.05% of the total counted.

$$P_x(t) = N(a; t) \exp \{-R_{x|a}(t) + A_{x,a}(t)\} L_x(t)/\ell_a(t) \quad (2.10)$$

where $N(a; t)$ are the people who reach their anniversary a during the year centered on time t , $R_{x|a}(t)$ and $A_{x|a}(t)$ are the accumulations of the specific growth rates and net international migration, respectively, from exact age “ a ” to completed age x , according to (B.35), and $L_x(t)$ are the person-years lived between the exact ages x and $x + 1$ and $\ell_a(t)$ the survivors at the exact age a , both biometric functions of the life table constructed for the year centered on t .

Because we do not have growth rates, net migration rates, or life tables for each year of the period 1950-2015, but we do have population and deaths in census years to construct mortality tables for those years, we look for a function $f(x)$ there, which together with the cohort effects assimilated to $\ln\{P_x(t)\} - f(x) - \ln\{L_x(t)/\ell_a(t)\}$:⁷

$$= e^{\ln\{P_x(t)\} - f(x) - \ln\{L_x(t)/\ell_a(t)\}}$$

Or, by taking the natural logarithm and solving for it:

$$\ln\{P_x(t)\} - f(x) - \ln\{L_x(t)/\ell_a(t)\} = 0 \quad (2.11)$$

If we consider only the population aged 3 years or older, where $a = 3$, we find a close linear association of $f(x)$ with respect to age, as can be seen in graph 2.15 from 1950 to 1980 and from 10 to 15 years from 1990 onwards.⁸ According to equation (2.10), it is

$$\ln\{P_x(t)\} - rx = \ln\{P_3(t)\} - 7t - \ln\{L_x(t)/\ell_3(t)\}$$

or, taking the exponential on both sides and solving:

$$P_x(t) = N(3, t)e^{-rx} e^{-7t} \ell_3(t) / L_x(t)$$

That is, the population adjusted by Gray 's method without cohort effects satisfactorily approximates the stable population associated with the mortality table for the year around t , where r is the stable growth rate, i.e., the slope of the fitted line in the panels of graph 2.17. The estimated population is:

$$P_x(t) = N(3, t)e^{-rx} e^{-7t} \ell_3(t) / L_x(t) \quad (2.12)$$

The linear trend indicates that misreporting of age—mainly digital preference—in population enumerations does not substantially affect age composition, except at the

⁷ Mortality tables were obtained from the rates resulting from dividing the deaths adjusted with the *Lowess procedure* by the smoothed populations $M_x(t) = D_x(t)/P_x(t)$. See Appendix D for the mortality table construction procedure used in this work.

⁸ The regression line was calculated using a robust method (STATA *rreg command*, 1993).

Declare age, perhaps provided by a third party rather than by oneself. In order to retain real effects on the age structure, we chose to maintain the population smoothed with Gray 's algorithm by superimposing cohort effects, and only add the stable population line in extreme old age, starting from the ages shown in Table 2.1. It should be mentioned that, from the inspection of the panels corresponding to the 2015 Intercensal Survey, instead of the regression line, for men we chose to linearly extrapolate $\ln |\pi^{(i)}|$ starting at age 103, based on the observations at ages 101 and 102, and for women, to superimpose the male behavior starting at age 98. By proceeding in this way, for all enumerations, we are primarily reassigning age in the aging population and transferring very few people before the ages in Table 2.1.

2.2.3 Estimating growth rates

The year-by-year and age-specific population figures deployed between 1950 and 2015, necessary to apply the mortality correction procedures, were obtained in two steps:

1. The total population aged three years or older was interpolated to the midpoint of each year of the period 1930-2015, fitting **cubic spline functions** (Burden and Luiros, 1988: 134-147) to the census totals between 1930 and 2015. We opened the time window from 1930 in order to have more observations for interpolation.
2. The smoothed age structures of the census years were linearly interpolated with respect to time to place them at the midpoint of each year of the period 1950-2015. The resulting distributions were superimposed on the interpolated total of 3 years or older.
mid-year.

The procedure was performed separately for each sex.

A clarification is necessary regarding 2005. Both the 2000 and 2010 censuses included a post -census survey to verify whether the unoccupied and temporarily occupied dwellings reported during the regular census were indeed unoccupied and not simply pending registrations—that is, occupied by permanent residents who were not counted. This verification recovered 341,126 pending dwellings in 2000, and only a few in 2010 (INEGI, 2012). In 2005, this post -census exercise was either deemed unnecessary or impossible to carry out , resulting in comparatively lower population coverage than the 2000 and 2010 censuses, as evidenced by the low population growth rates between 2000 and 2005 and the high rates between 2005 and 2010. In order to avoid strong fluctuations in the temporal trend of the total population aged 3 years or older, we opted to interpolate the population figure for the 2005 census date using the geometric growth model of the populations published in 2000 and 2010 ; the estimated population was then overlaid with the age composition collected in the 2005 census, smoothed with Gray 's algorithm and cohort effects.¹⁰

⁹ Information provided by INEGI officials in 2006.

¹⁰ For the total population aged 3 and over, the exponential growth rates, based on the 2000 and 2010 censuses and the 2005 count, were 1.05% for males, 1.17% for females, and 1.11% for the total

Figure 2.17. Population by age and sex and associated stable population, 1950-2015

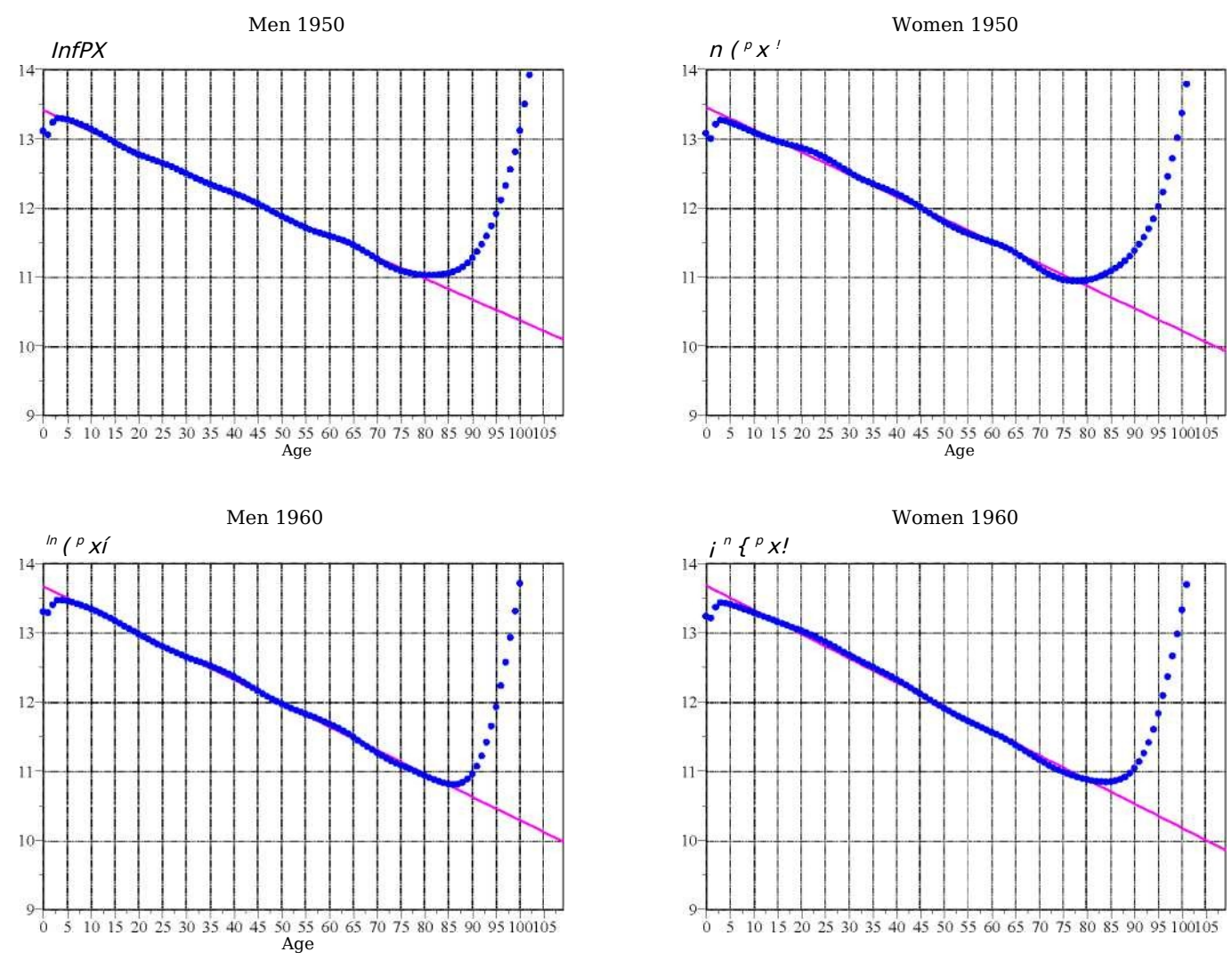


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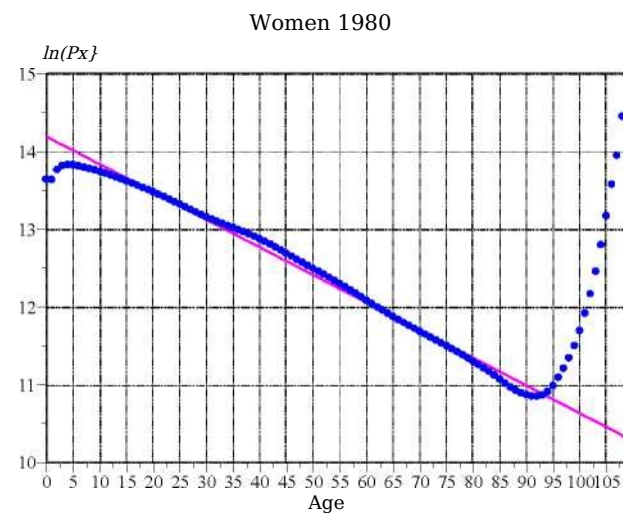
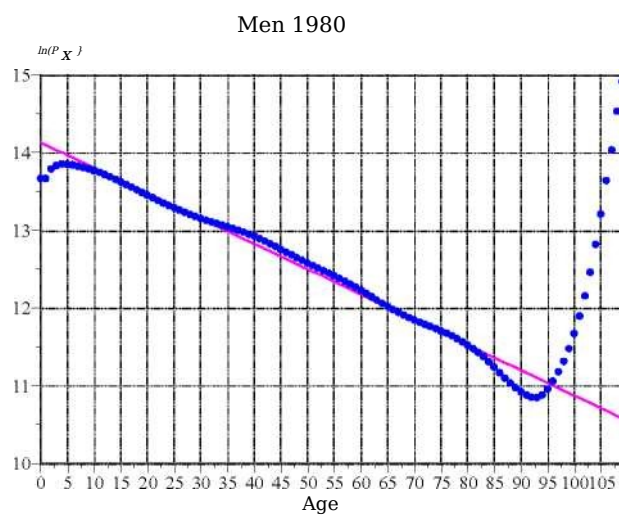
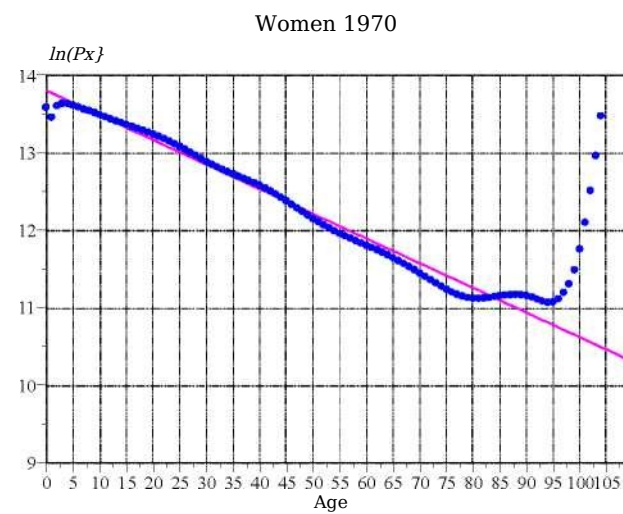
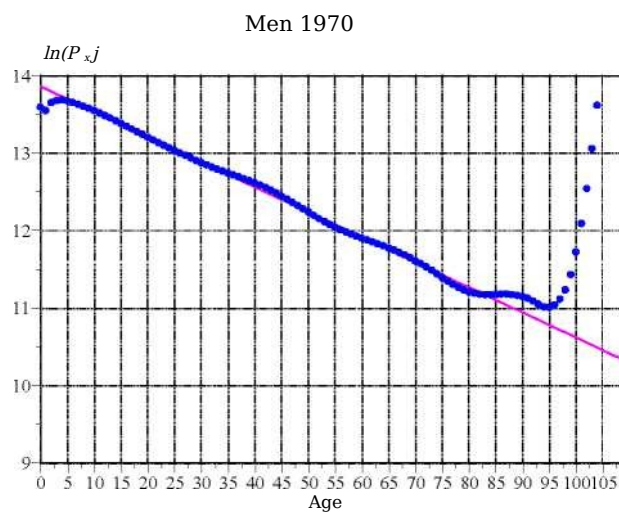


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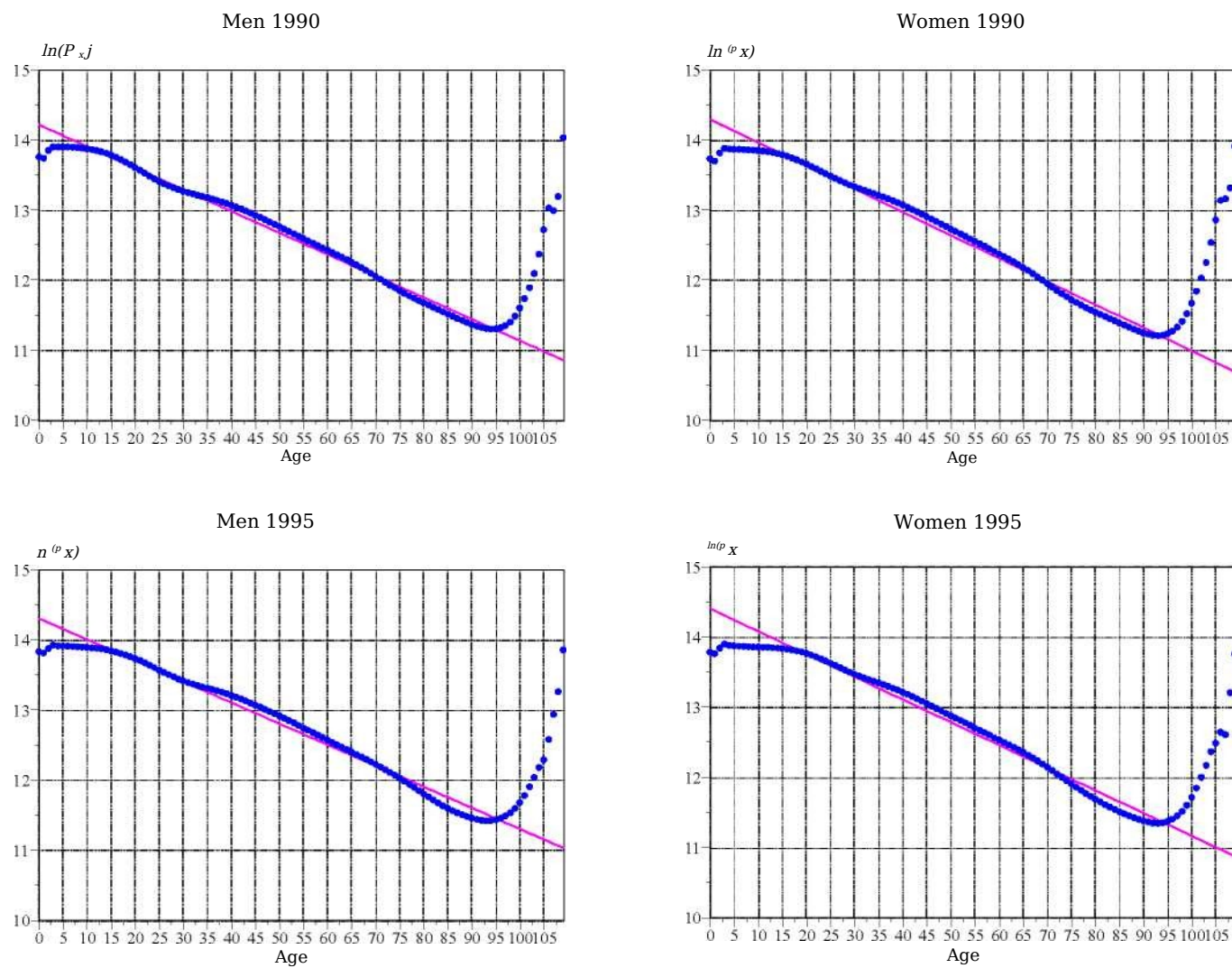


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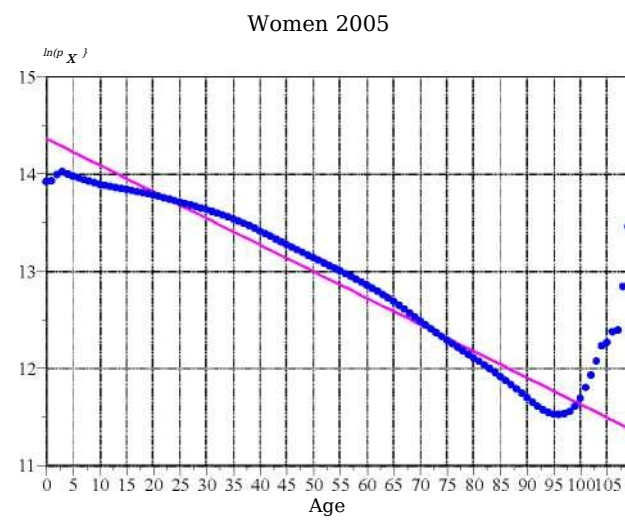
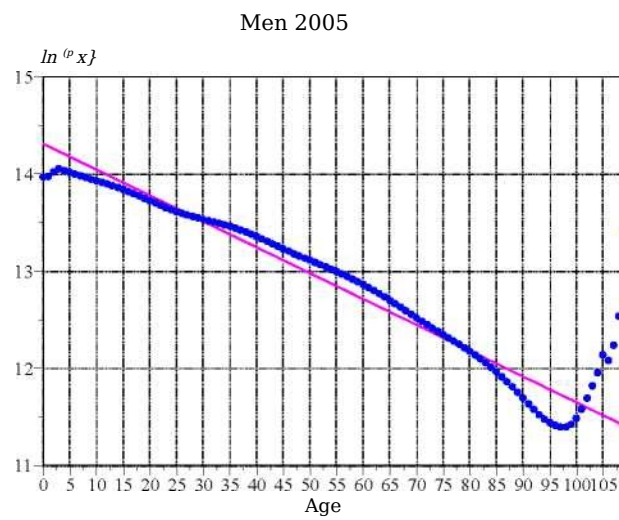
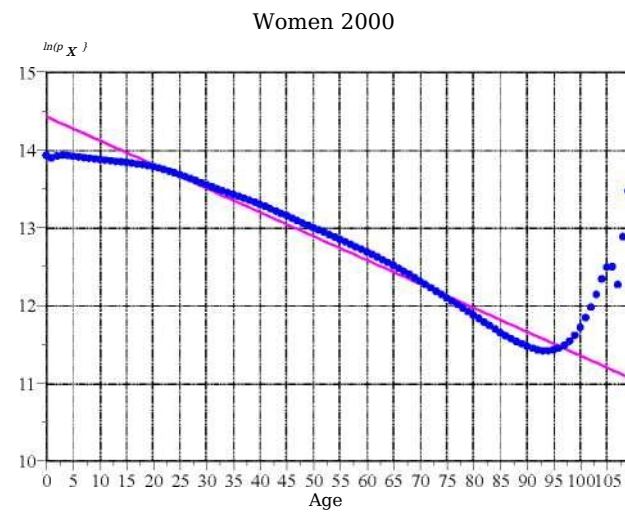
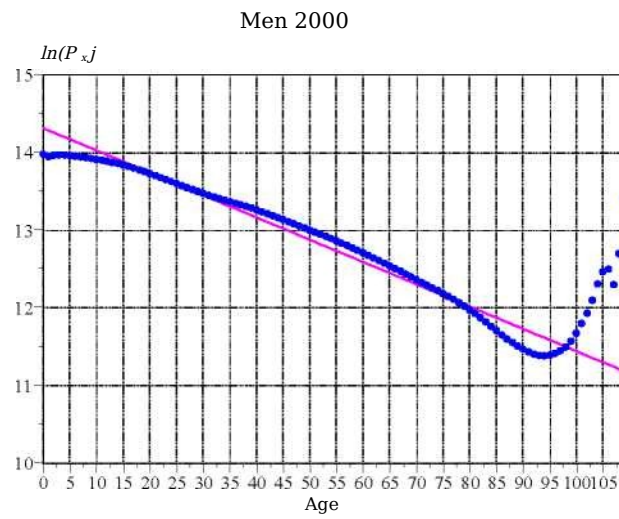
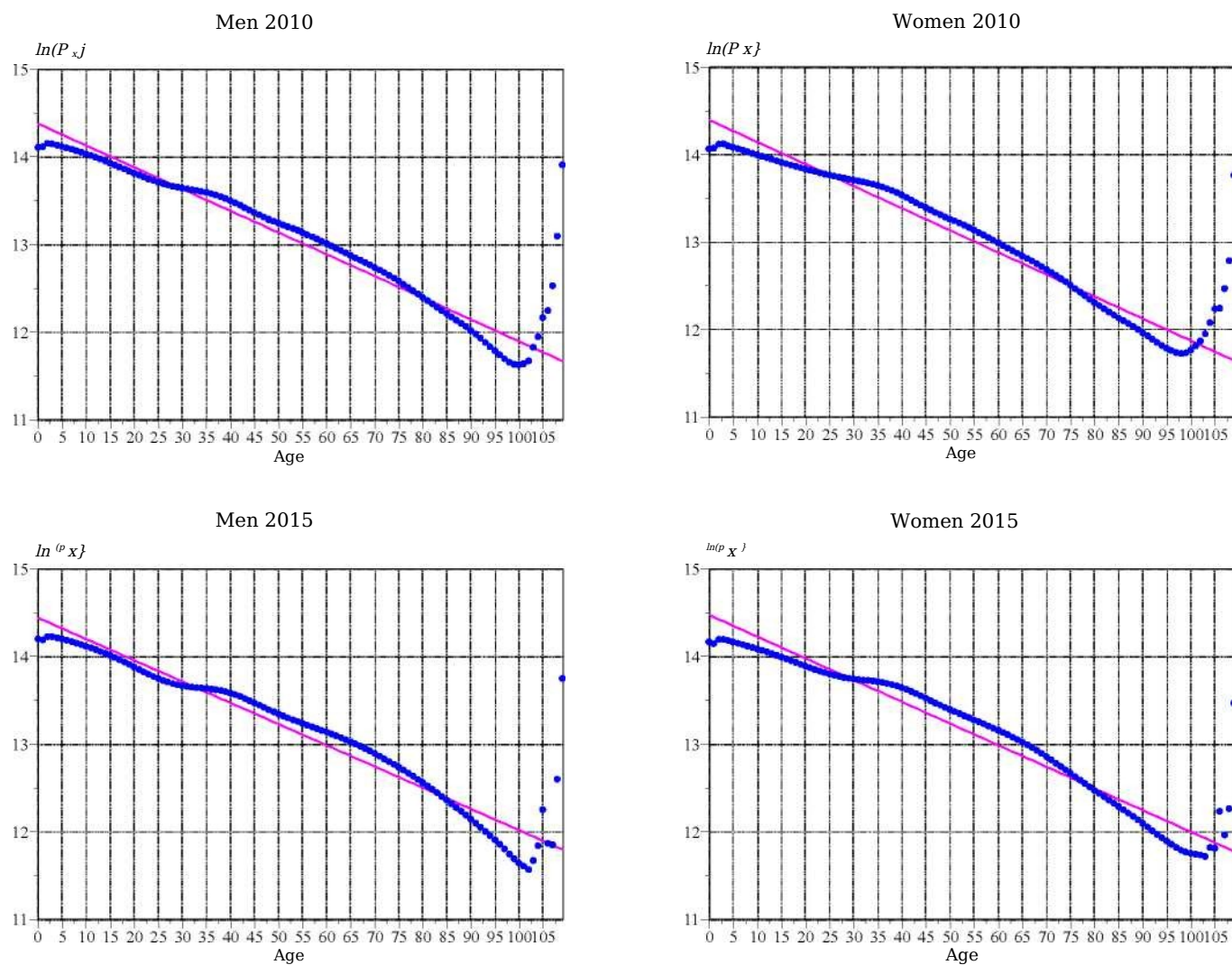


Figure
2.17.
(Conclude



Source: Population censuses and vital statistics, 1930-2015.

Year	Men	Women
1950	79	67
1960	85	81
1970	75	66
1980	82	78
1990	91	91
1995	75	73
2000	79	75
2005	81	75
2010	82	76
2015*	103	98

* See the text for extrapolation.

Source: Figure 2.17.

The visible linear behavior of (x) with respect to age shows that the population of Mexico without cohort effects can be satisfactorily approximated with a stable population; therefore, this model was adopted as the basis for estimating the age growth rates for all years of the period 1950-2015.

It should not be overlooked that the deviation of the stable population from the Gray-smoothed age structure (the less evident linearity in the later panels of Figure 2.13) may well be a cumulative consequence of international migration across generations. The mortality rate correction algorithms, based on the general growth model (see Appendix B), require total growth rates—that is, the combined effect of birth rate (at the origin of the generation), mortality, and international migration—as well as, explicitly, rates of mobility with other countries.

In equation (2.12) we are not including international migration because in (2.7) we calculate the cohort effects as the arithmetic mean of the residuals from the additive-double multiplicative adjustment for all the years each generation spends between 1930 and 2014. Thus, in estimating the age-specific growth rates, we will implicitly assume that the population is closed to international migration. We will explain how this is done below.

in 2000-2005 and 2.08%, 1.91%, and 1.99%, respectively, for 2005-2010. For the five-year periods covering the decade: 1.34% for men, 1.79% for women, and 1.57% for the total during 1995-2000, and 1.25%, 1.46%, and 1.36%, respectively, in 2010-2015. The intercensal growth rates 2000-2010, which we assume to be constant for the 2005 estimate, are 1.52%, 1.50%, and 1.51%, respectively. It is under this temporal trend that we consider the rates for the first half of the decade 2000-2010 to be low and those for the second half to be high.

This assumption is relaxed when applying mortality correction procedures.

The growth rate for age x during year t is:

-2 - 131

Therefore, it is necessary to determine the populations at the beginning and end of each year to estimate the corresponding growth rates.

Cohort effects, having been extracted from deaths, can be located at mid-year, since deaths are distributed approximately evenly throughout the year. If we take the age reached at mid-year f as the midpoint, the cohort effects refer to the generation born in year $t-x$, which actually corresponds to the period from July 1st of calendar year $t-x-1$ to June 30th of year $t-x$. If we retain the mid-year age reference for cohort effects, the population at the beginning of the year comprises both the generation born in $t-x$ and the one born in the previous "year," that is, in $t-x-1$.

If the population is assumed to be uniformly distributed within each individual age group, the cohort effect of the population at the beginning of the year can be approximated as the average of the cohort effects of the two generations involved (referred to at the middle of the year), that is,

$$\frac{1}{2} [P_{t-x-1} + P_{t-x}]$$

whereby, by (2.12)

$$P_{x,t} = N(3,t) e^{r_x(t-x)} \frac{1}{2} [P_{t-x-1} + P_{t-x}]$$

By analogous reasoning we have:

$$P_{x,t+1} = N(3,t+1) e^{r_x(t+1-x)} \frac{1}{2} [P_{t-x} + P_{t-x+1}]$$

If both equalities are substituted into (2.13)

$$r_x(t) = \ln \frac{P_{x,t+1}}{P_{x,t}} = \ln \frac{N(3,t+1)}{N(3,t)} + \frac{r_x(t-x+1) - r_x(t-x)}{2}$$

And since in a stable population the growth rate r is the same for all ages:

$$r = \ln \frac{N(3,t+1)}{N(3,t)} \quad (2.14)$$

so:

$$r_x(t) = r + \frac{r_x(t-x+1) - r_x(t-x)}{2} \quad (2.15)$$

For census years the calculation is straightforward, since both the stable growth rates (slope of the robust linear regressions estimated with equation 2.11) and

The cohort effects; however, for the intermediate years, only the second effects are known. Based on the temporal sequence of stable growth rates for census years, those corresponding to the intermediate years were obtained by interpolation with **cubic spline functions**. As will be seen later, both this adjustment and the assumption of stability in (2.14) are corrected by applying the mortality level correction methods.

The initial age-specific mortality rates for all years in the period 1950–2015 were obtained as the ratio of deaths adjusted using the **Lowess procedure** to the estimated mid-year populations, according to the procedure described above in this section. Together with the early life mortality rates from section 2.1, they were smoothed using the Heligman and Pollard model (1980).

$$q_x = A^{(x+b)} \cdot De^{E[\ln\{x/F\}]^2} \cdot \frac{GH^x}{1 + GH}$$

using five-year age intervals from 5-9 to 80-84.¹¹ The time trend of the probabilities of deaths $q_x(t)$ was smoothed with the **Lowess procedure** and a window of 15% of the observations. The excess mortalities of 1951, 1953 and 1970 were superimposed on the smoothed series. The new probabilities were again smoothed with the Heligman and Pollard model (1980). The probabilities and mortality rates by age displayed were those used in the following section and in Chapter 4 when retrospectively examining international migration.

2.2.4 Mortality level correction

Once the growth rates were determined, it was necessary to obtain the international migration rates by age. Migration rates were calculated directly by dividing the number of international migrants by age by the populations estimated in the previous section. The method used to determine the number of international migrants and their associated contingency rates is described in Chapter 4.

2.2.5 Linear regression with the general model

In the previous section and the paragraph above, we explained how the inputs were estimated to calculate the coefficients in equation (B.42), that is, the coverage factors for growth rates, net international migration, and age-specific mortality rates, starting from age 5. It is clear that by separating growth rates from those related to territorial mobility, the correction coefficient $k_{sub>r</sub>}$ addresses the assumption of the absence of migration in our calculation of the total growth rate.

In order to examine the effect of including or omitting international migration, Figure 2.18 contrasts the correction factors for mortality rates

¹¹ The conversion of rates into probabilities and the subsequent extension up to 109 years of age is explained in Annex D, where the algorithm followed in the construction of life tables is described.

of both cases.¹² It is noted that, in general, the inclusion of international migration barely increases the relative coverage of deaths with respect to the census population, more significantly among women. Including international migration is a more realistic scenario; thus, we retained the mortality correction factors obtained by incorporating territorial mobility.

2.2.6 Application of the Bennett and Horiuchi method

As mentioned above, if the age structures of the populations, deaths, and growth and migration rates are consistent with each other, the relative coverage for all ages should be equal; that is, when applying the Bennett and Horiuchi model and graphing by age, a straight line with zero slope should be obtained, parallel to the *x-axis*, which intersects the y-axis **at the k_M** value of the relative coverage of deaths with respect to the census population.

According to diagnoses derived from simulations (Preston *et al.*, 1980; Florez, 1983; Bennett and Horiuchi, 1984), an underestimation of recorded growth rates results in a positive slope; conversely, an overestimation of growth rates results in a negative slope. To achieve a straight line with a zero slope, a factor ***h*** was introduced to modify growth rates equally at all ages.

$$r_x(t) = h + r_x(t)$$

It can be seen, according to (2.15), that the constant ***h*** should only modify the steady-state growth rate *r*, since cohort effects remain unchanged over time:

$$\frac{r_x(t) = r + h + \frac{1}{Y_0} \left(\frac{d_x(t)}{N_x(t)} - \frac{d_x(t-h)}{N_x(t-h)} \right)}{(2.16)}$$

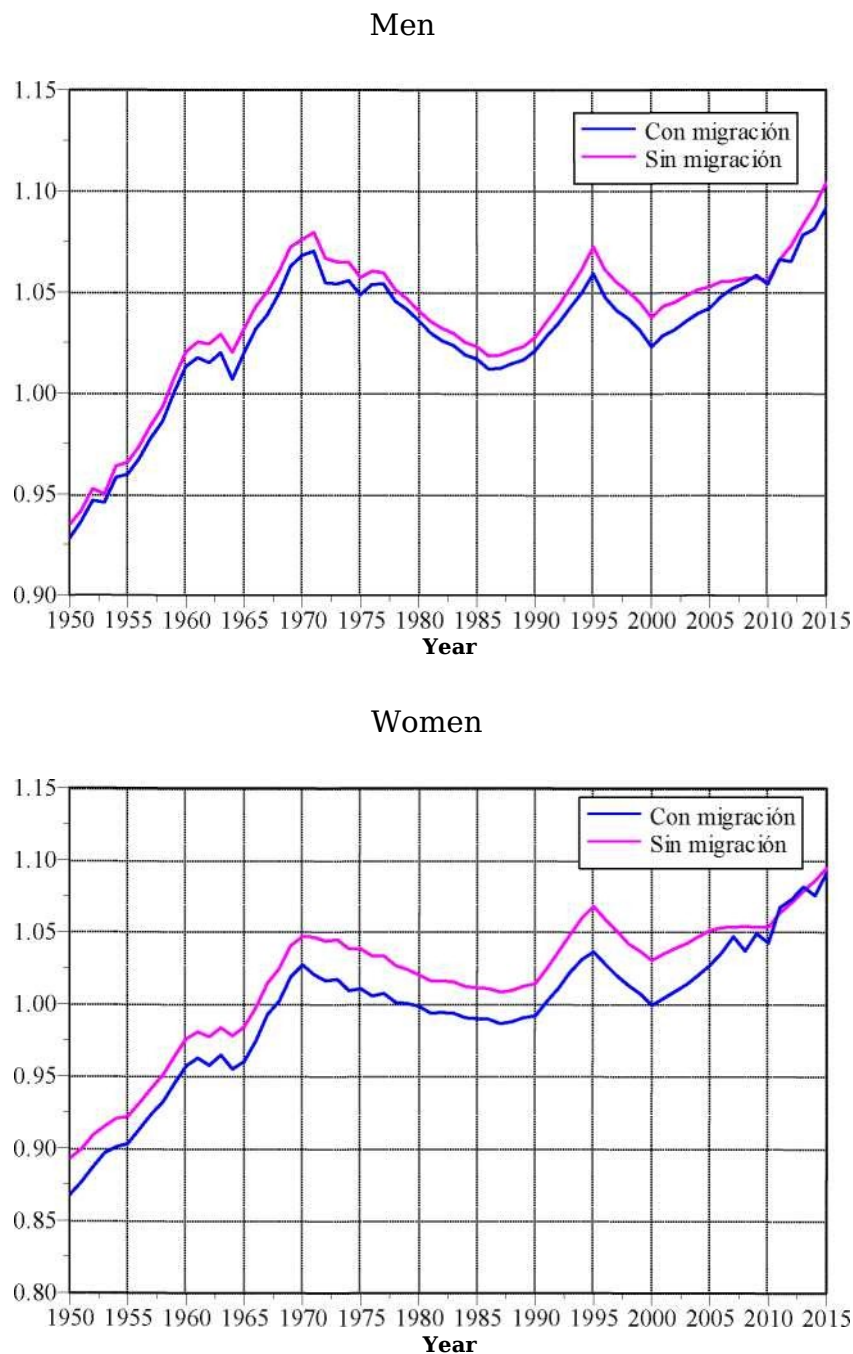
The application of the Bennett and Horiuchi method then consisted of successively modifying the ***h*** factor until obtaining a similar relative coverage of deaths at all ages (zero slope).

From the theory of stable populations (Lotka, 1939), it is known that the growth rate *r* is not only invariant across age ranges but also over time. In fact, in (2.14) the rate refers to the growth of the population reaching its anniversary ***a*** and it might be more appropriate to express it as ***r(a, t, t + 1)***. Since it is not possible to estimate the growth rate for the exact age ***a***—the minimum considered for applying the Bennett and Horiuchi model—for all years of the period 1950–2015, we approximate it with the “stable” growth rate using the artifice in (2.14). As can be seen, any bias in the estimation of ***r(a, t, t + 1)*** is corrected by the factor ***h*** in (2.16).

For a more accurate estimate of the degree of coverage of recorded mortality for people aged five years and over, that is, a better application of the Bennett and Horiuchi method, some adjustments were made to the age compositions of deaths and populations so that both would be as similar as possible and conveniently satisfy

¹² The omission of the migration consisted of eliminating the term **$k|_n A_{x;a}(t, t + h)$** on the right side of equation (B.42).

Figure 2.18. Correction factors for mortality rates by sex, calculated by regression with and without migration,



Source: Estimates based on vital statistics and population enumerations

1950-2015

The assumption of equal coverage across all age groups was used. Subsequent adjustments were made using the general growth model, which is presented in Annex B.

The age structures of deaths and the population are highly varied and difficult to model; however, the age pattern of their ratio—the mortality rate—is characteristic of the human species, and its variants (for example, model life tables) refer to the relationship between the incidence of the phenomenon at early and late ages with respect to the average lifespan. Thus, our estimate of the coverage level focuses on the age pattern of mortality rates $M_x(t)$. Using (B.34)—with the growth rates calculated using (2.15) and those of international migration—the age composition of the population was estimated, which was superimposed on the total population aged 5 years and over estimated at mid-year for the period 1950-2015. Multiplying this population by the smoothed rates yielded the age structure of deaths, which was superimposed on the total number of registered deaths of people aged 5 years and over.

Once the age compositions of deaths and population were reconciled, the Bennett and Horiuchi model (B.44) was applied, successively modifying the value of h in (2.16) until the slope of the linear regression of the correction factors was not statistically different from zero with a 95% confidence level. The y-intercept of the last regression line was taken as the final value of c (see equation B.28); the mortality correction factor is $= 1/c$.

As an example, Figure 2.19 shows the first set of factors, corresponding to the end of the iterative process and the final one (the y-intercept of the last regression) for men in 2010. It can be seen that the final value is practically constant up to age 97 and after that there is hardly any increase.

The correction of mortality rates is shown in Figure 2.20. The coverage of deaths is closer to the entire census population (value of A' , closer to unity)) when territorial mobility is included, although not in all years. Again, considering it a more realistic scenario, we retained the estimate with migration.

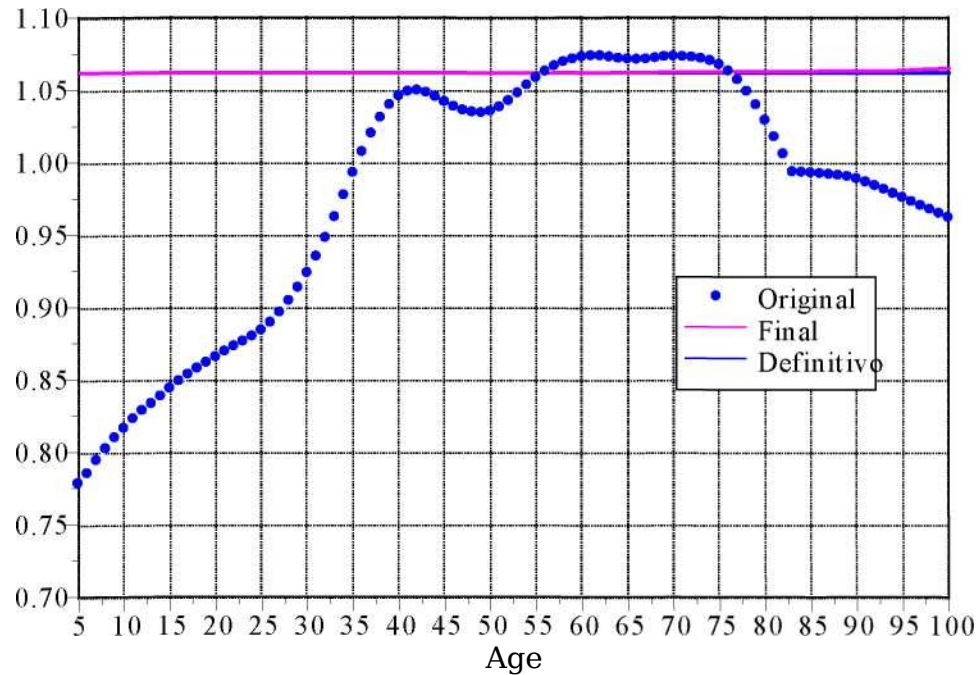
2.2.7 Selection of the final correction

We have two estimates of the correction factors for age-specific mortality rates: one using the linear equation for rate accumulation (B.42); and the other using the Bennett and Horiuchi model. The question is which of these two estimates we should use.

The coverage of vital statistics and enumerated populations is similar and close to complete, making it desirable to minimize adjustments to the base data. Figure 2.21 shows that, in most years and for both sexes, the regression estimate from equation (B.42) is closer to unity than the Bennett and Horiuchi estimate; therefore, we decided to use the regression estimate for both sexes throughout the period 1950-2015. However, it was deemed appropriate to make some manual adjustments to the time trajectory.

There is evidence, drawn from separate modules in the **ENADID** surveys of 1992 and 1997, of an omission of close to 5% in deaths of 1 year of age or older in vital statistics (see the

Figure 2.19. Mortality rate correction factor estimated by the Bennett and Horiuchi method , Men, 2010



Source: Estimates based on population enumerations and statistics 1950-2015

Section 8.2). Recent reconciliation exercises (Partida, 2003 and 2008; SOMEDE, 2011) show that the omission in the censuses and counts from 1950 to 2010 for people aged 3 years and older rarely exceeded 3%. Thus, in the best-case scenario, the coverage of deaths and enumerated populations should be equal to, or better than, that of the censuses and counts.

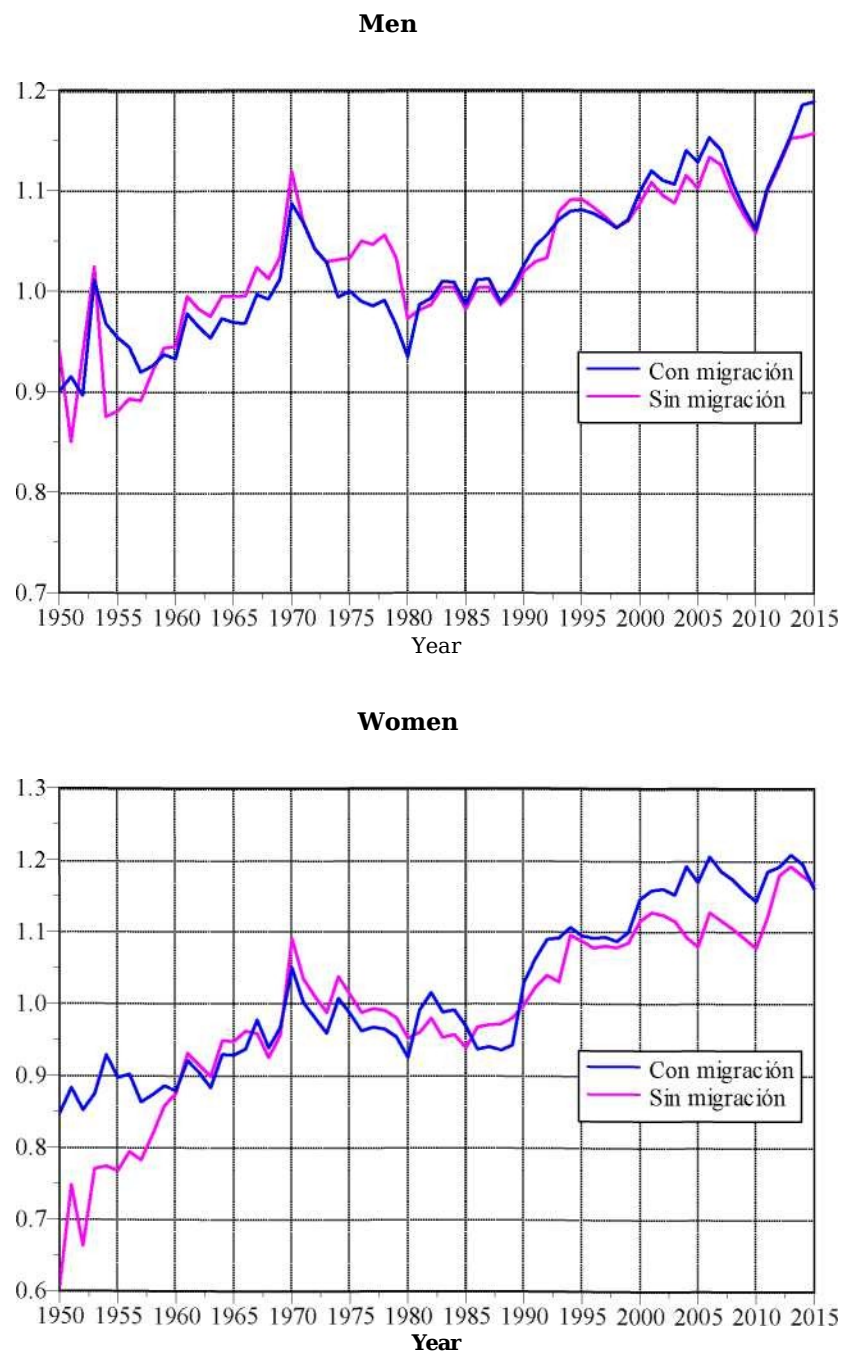
Based on that information, we retained the largest number of values with $k(t)$ **migration** in the two panels of graph 2.16, but removed the values less than one:

1. The male factor for 1960 (1.0132) remained constant for the previous ten years, and the same factor was assigned to females from 1950 to 1960. In the case of females, it was also linearly interpolated between 1960 and 1970, taking the male temporal pattern as the independent variable.¹³

¹³ If $C_m(t) = 1/k_m(t)$ is the male factor for year t and $C_f(t) = 1/k_f(t)$ the female factor, the interpolation is:

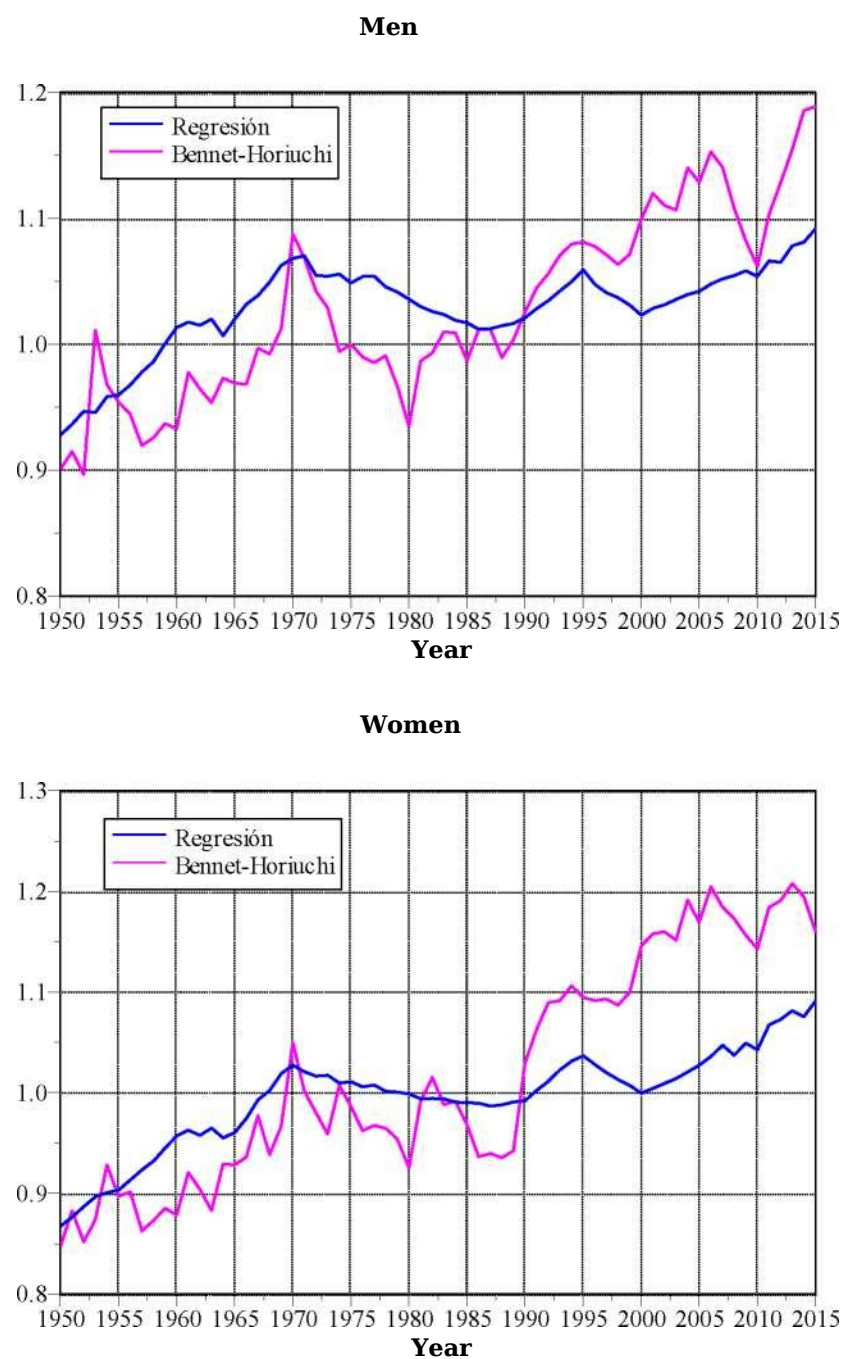
$$C_m(1960+i) = C_m(1960) + \frac{C_m(1970) - C_m(1960)}{10} \cdot i \quad \left| \quad C_m(1960+i) = C_m(1960) \quad t = 1, 2, \dots, 9 \right.$$

Figure 2.20. Correction factors for mortality rates by sex, Bennett and Horiuchi method with and without migration,



Source: Estimates based on vital statistics and population enumerations

1950-2015

Figure 2.21. Correction factors for mortality rates by sex,

Source: Graphs 2.14 and 2.16.

Year	Men	Women	Year	Men	Women	Year	Men	Women
1950	1.01318	1.01318	1972	1.05458	1.01639	1994	1.04965	1.03135
1951	1.01318	1.01318	1973	1.05401	1.01738	1995	1.05920	1.03660
1952	1.01318	1.01318	1974	1.05566	1.00945	19%	1.04756	1.02798
1953	1.01318	1.01318	1975	1.04867		1997	1.04102	1.01990
1954	1.01318	1.01318	1976	1.05381	1.01082 1.00577	1998	1.03697	1.01311
1955	1.01318	1.01318	1977	1.05404	1.00756	1999	1.03116	1.00734
1956	1.01318	1.01318	1978	1.04550	1.00137	2000	1.02302	1.00580
1957	1.01318	1.01318	1979	1.04144	1.00127	2001	1.02853	1.00426
1958	1.01318	1.01318	1980	1.03573	1.00112	2002	1.03135	1.00911
1959	1.01318	1.01318	1981	1.02991	1.000%	2003	1.03560	1.01398
1960	1.01318	1.01318	1982	1.02600	1.00086	2004	1.03945	1.02050
1961	1.01756	1.01431	1983	1.02359	1.00080	2005	1.04197	1.02727
1962	1.01500	1.01365	1984	1.01897	1.00068	2006	1.04783	1.03592
1963	1.01998	1.01493	1985	1.01695	1.00062	2007	1.05187	1.04706
1964	1.00685	1.01155	1986	1.01194	1.00049	2008	1.05445	1.03713
1965	1.01988	1.01490	1987	1.01233	1.00053	2009	1.05834	1.04926
1966	1.03174	1.01795	1988	1.01469	1.00078	2010	1.05389	1.04261
1967	1.03873	1.01975	1989	1.01650	1.00097	2011	1.06608	1.06741
1968	1.04923	1.02245	1990	1.02104	1.00144	2012	1.06509	1.07283
1969	1.06272	1.02592	1991	1.02830	1.00220	2013	1.07817	1.08154
1970	1.06819	1.02733	1992	1.03456	1.01131	2014	1.08117	1.07550
1971	1.07019	1.02070	1993	1.04232	1.02267	2015	1.09152	1.09119

Source: Graph 2.22.

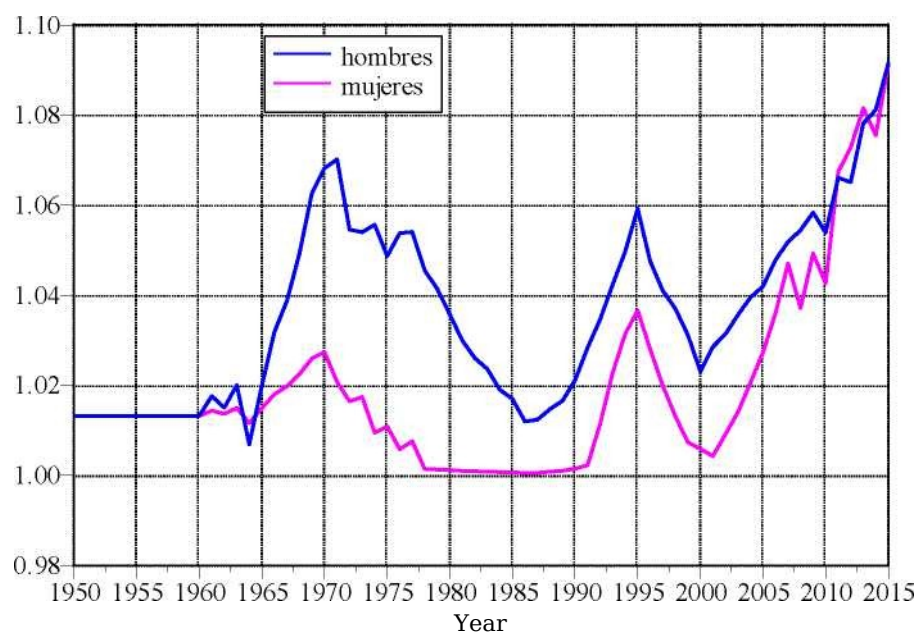
2. Based on the female trajectory, we arbitrarily set the value for 1986 (1.0049), and again we linearly interpolated in 1979-1985 and 1987-1990, with the most culino pattern as the dependent variable.
3. Finally, the female factor for 2000 was estimated as the square root of the values for 1999 and 2001.

The final mortality correction factors ($C(t) = I/k(t)$) for each year and sex are reproduced in graph 2.22 and table 2.2.

2.3 Recent trends in mortality

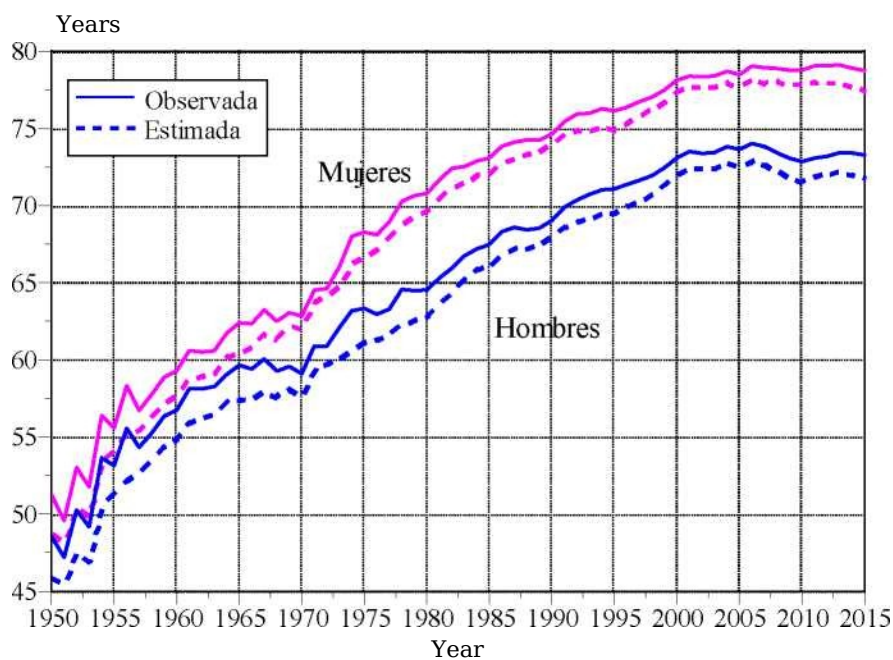
Life expectancy is undoubtedly the best summary measure of mortality levels, as its calculation eliminates the distorting effect of age structure on the crude death rate. Figure 2.23 and Table 2.3 contrast “observed” and “adjusted” life expectancies; that is, those derived directly from births and deaths recorded in the civil registry and census populations, and those obtained from the adjustments made in this chapter. In all years, the observed life expectancies are

Figure 2.22. Definitive factors for correcting mortality rates by sex, 1950-



Source: Estimates based on population enumerations and vital statistics 1950-2015

Figure 2.23. Life expectancy at birth by sex with observed and estimated mortality, 1950-

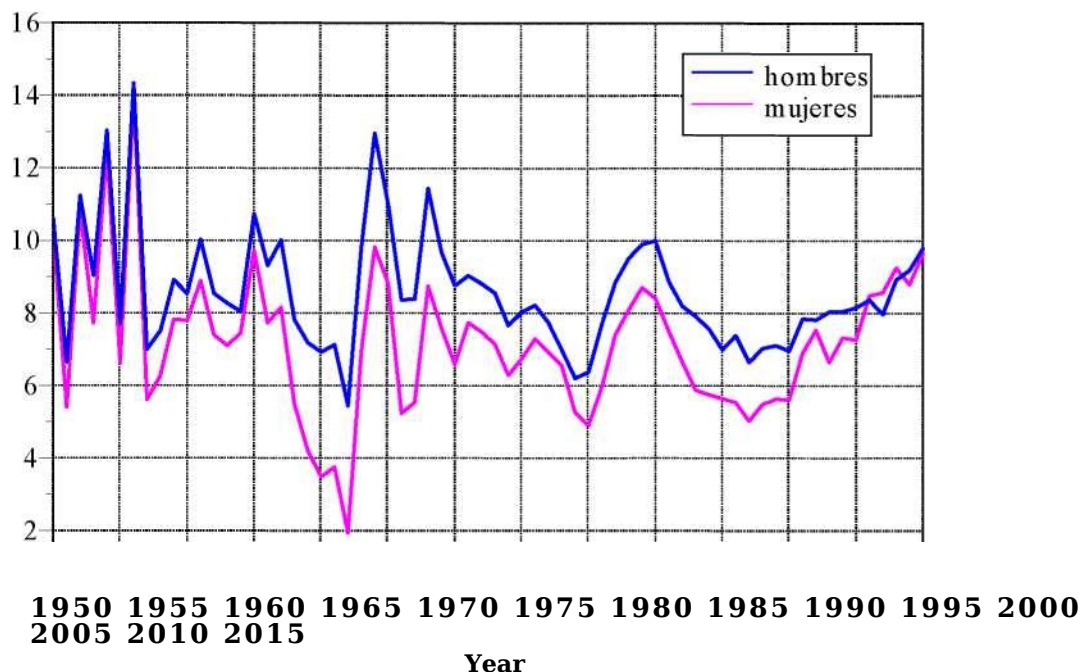


Source: Table 2.3.

Year	Census and vital		Dear		Year	Census and vital		Dear		Year	Census and vital		Dear	
	Men	Women	Men	Women		Men	Women	Men	Women		Men	Women	Men	Women
1950	48.99	52.06	46.34	49.55	1972	61.32	65.39	60.74	65.29	1994	71.00	76.51	69.94	75.51
1951	47.77	50.48	45.41	48.43	1973	62.49	66.77	61.16	65.94	1995	71.10	76.49	70.25	75.75
1952	50.73	53.81	48.27	51.50	1974	63.53	68.96	61.56	66.60	1996	71.37	76.69	70.57	76.09
1953	49.75	52.61	45.26	50.27	1975	63.63	68.91	61.92	67.24	1997	71.57	76.82	70.89	76.24
1954	54.03	57.09	50.35	53.55	1976	63.24	68.71	62.24	67.87	1998	71.79	77.02	71.20	76.50
1955	53.59	56.37	51.41	54.60	1977	63.49	69.50	62.58	68.47	1999	72.23	77.34	71.51	76.74
1956	55.98	59.07	52.43	55.62	1978	64.72	70.70	62.94	69.05	2000	72.78	77.84	71.81	76.94
1957	54.73	57.45	53.36	56.55	1979	64.58	71.04	63.35	69.61	2001	73.17	78.09	72.09	77.29
1958	55.66	58.48	54.18	57.36	1980	64.58	71.12	63.79	70.15	2002	73.04	78.09	72.35	77.49
1959	56.72	59.60	54.88	58.06	1981	65.32	71.91	64.28	70.68	2003	73.10	78.03	72.56	77.59
1960	57.11	60.03	55.49	58.66	1982	65.95	72.65	64.81	71.19	2004	73.46	78.30	72.70	77.73
1961	58.51	61.33	56.05	59.23	1983	66.73	72.75	65.36	71.69	2005	73.30	78.12	72.77	77.83
1962	58.52	61.26	56.60	59.80	1984	67.21	73.18	65.91	72.16	2006	73.67	78.62	72.78	77.93
1963	58.68	61.35	57.12	60.37	1985	67.51	73.34	66.43	72.59	2007	73.53	78.53	72.76	77.99
1964	59.44	62.46	57.58	60.91	1986	68.32	74.04	66.91	72.98	2008	73.18	78.46	72.73	78.09
1965	60.05	63.16	57.97	61.39	1987	68.63	74.34	67.36	73.34	2009	72.83	78.46	72.70	78.19
1966	59.82	63.12	58.30	61.85	1988	68.53	74.42	67.77	73.70	2010	72.71	78.51	72.72	78.29
1967	60.40	63.92	58.64	62.33	1989	68.60	74.49	67.97	73.88	2011	72.96	78.78	72.72	78.36
1968	59.71	63.32	59.02	62.86	1990	69.11	74.83	68.37	74.23	2012	73.13	78.89	72.82	78.41
1969	59.91	63.75	59.51	63.49	1991	69.92	75.66	68.94	74.70	2013	73.47	79.09	72.93	78.52
1970	59.36	63.45	58.14	62.16	1992	70.37	76.16	69.29	74.99	2014	73.50	78.99	73.13	78.62
1971	61.31	65.21	60.31	64.65	1993	70.70	76.15	69.63	75.26	2015	73.85	79.28	73.28	78.69

Source: Estimates based on population enumeration and vital statistics 1950-2015.

Figure 2.24. Percentage underestimation of the overall level of mortality when calculated directly from vital statistics and census populations, by sex, 1950-2015



Source: Estimates based on population enumerations and statistics 1950-2015

older, that is, the overall level of mortality is underestimated when calculated directly from

vital statistics and population censuses. The overall omission varies in men from less than 2.8% in 1970 to 13.8% in 1956, and in women in the same years of 1.1 to 13.7%.

Figure 2.24 shows the contribution of three major age groups to the difference between observed and estimated life expectancy. The recognized underreporting of deaths in the first year of life is evident: in most of the 66 years considered, the underestimation of the risk of dying before the first birthday accounted for most of the increase in average lifespan. Likewise, among those aged one year and older, the better coverage of deaths by civil registry records compared to census data in some years is reflected in the negative contribution—reduction in “real” life expectancy—of individuals aged one year and older. It is worth remembering that, due to a relative underreporting in the denominator (census population) compared to the numerator (deaths in vital statistics), higher mortality rates lead to a lower life expectancy at birth. Table 2.4 presents the differences in life expectancies, their origin in the three age groups considered, and the overall underreporting of mortality levels for the

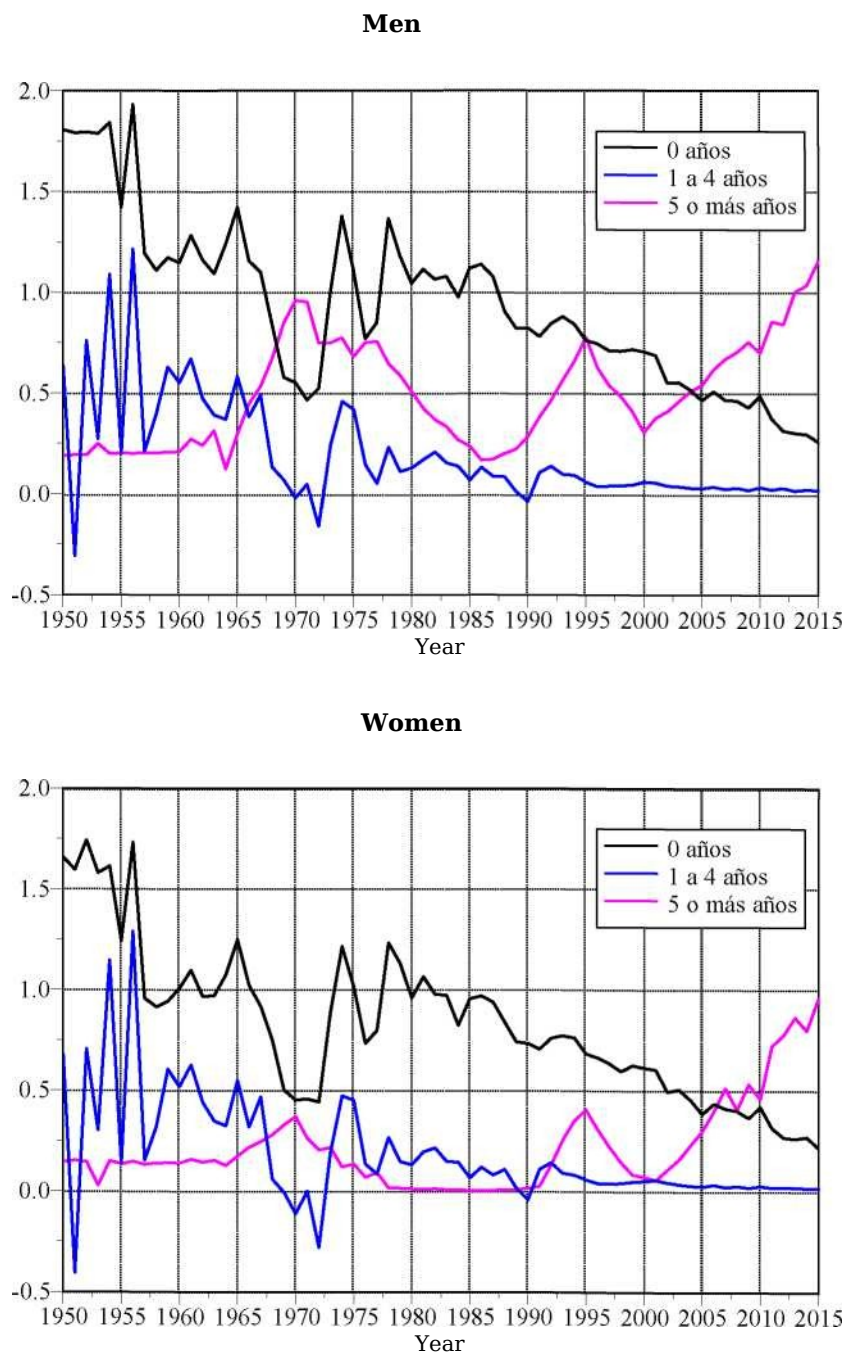
census years.

Figure 2.25 illustrates the overall omission in calculating the country's mortality rate directly from births and deaths in vital statistics and population censuses. A pattern emerges, initially low but rapidly rising in recent years, perhaps due to the difficulty of registering victims of the rampant crime in the country. Finally, Figure 2.26 shows the probabilities of dying by age and sex for 1950, 1990, and 2015.

Year	Censuses and vital records	Dear	Total	0 years	1-4 years	5 years or more	global omission
Men							
1950	48.99	46.34	2.65	1.82	0.62	0.21	10.6
1960	57.11	55.49	1.62	1.16	0.54	-0.07	7.2
1970	59.36	58.14	1.22	0.55	-0.03	0.70	5.7
1980	64.58	63.79	0.79	1.05	0.12	-0.38	4.1
1990	69.11	68.37	0.74	0.83	-0.04	-0.04	4.4
1995	71.10	70.25	0.86	0.76	0.06	0.04	5.4
2000	72.78	71.81	0.97	0.70	0.06	0.21	6.4
2005	73.30	72.77	0.53	0.46	0.03	0.04	3.6
2010	72.71	72.72	-0.01	0.49	0.03	-0.53	-0.1
2015	73.85	73.28	0.57	0.26	0.02	0.29	3.9
Women							
1950	52.06	49.55	2.51	1.68	0.65	0.17	10.3
1960	60.03	58.66	1.37	1.02	0.50	-0.15	6.4
1970	63.41	62.16	1.25	0.45	-0.12	0.92	6.2
1980	71.13	70.15	0.98	0.96	0.12	-0.11	5.9
1990	74.83	74.23	0.61	0.73	-0.05	-0.08	4.2
1995	76.40	75.75	0.65	0.69	0.05	-0.09	4.8
2000	77.84	76.98	0.86	0.61	0.05	0.20	6.6
2005	78.12	77.83	0.28	0.38	0.02	-0.12	23
2010	78.50	78.26	0.24	0.42	0.02	-0.21	1.9
2015	79.28	78.69	0.58	0.22	0.01	0.35	4.8

* Refers to the overall percentage of undercoverage of observed rates compared to adjusted rates.

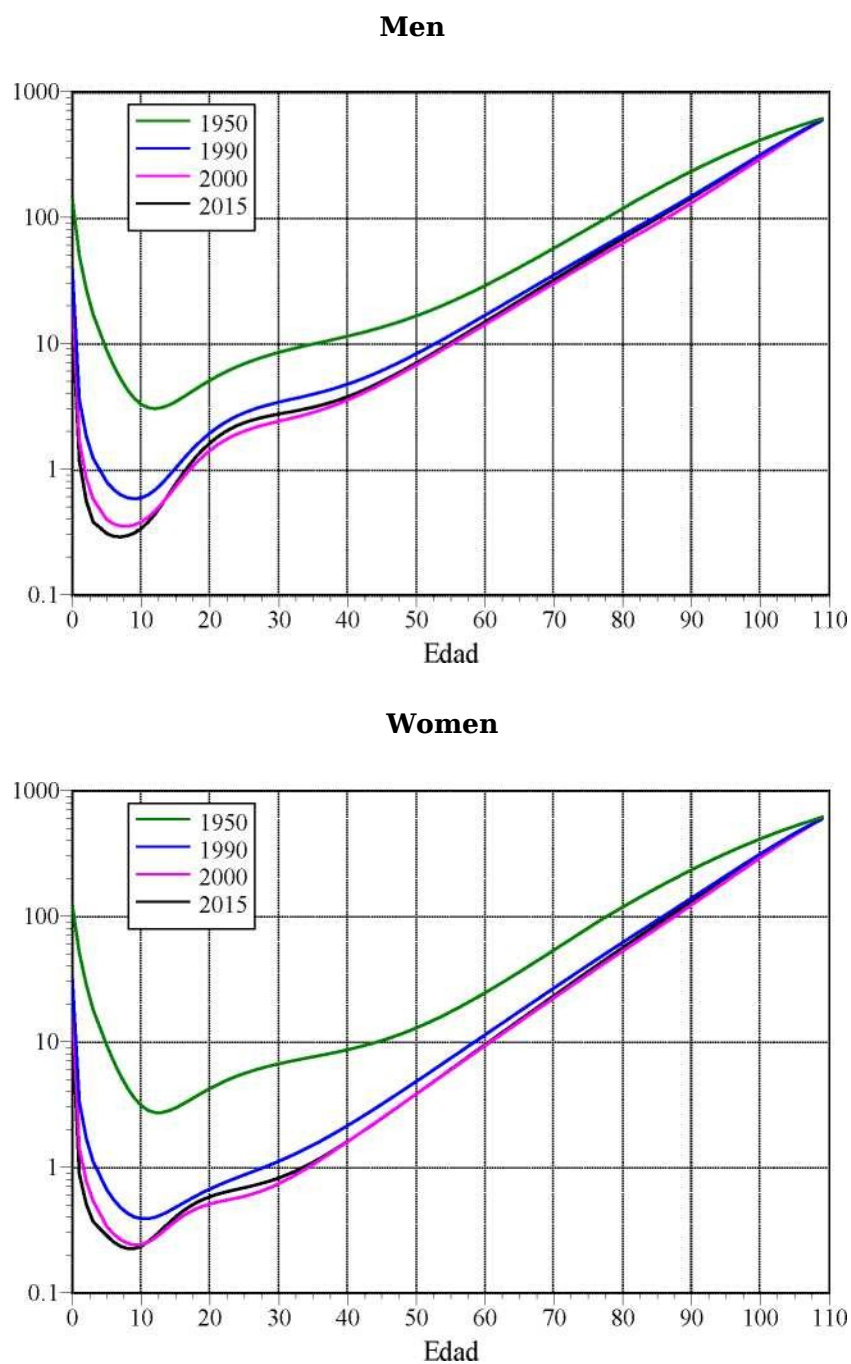
Figure 2.25. Contribution of three age groups to the favorable difference in observed versus estimated life expectancy, 1950-



Source: Estimates based on vital statistics and population enumerations

© 1950-2015

Figure 2.26. Probabilities of dying by age and sex, 1950, 1990 and 2015
(per thousand)



Source: Estimates based on vital statistics and population enumerations
from 1950 to 2015

3. National fertility

In recent decades, fertility, along with international migration, has been the main determinant of population growth and changes in its age structure, and this effect is expected to continue in the coming years. The country has several sources for fertility analysis. Vital statistics, population censuses, fertility surveys, and, in recent years, birth certificates constitute a rich body of information that allows for extensive analytical possibilities.

In the past, most studies aimed at calculating fertility and birth rates and trends were based on births registered in vital statistics. However, a long-standing problem in our country is the lack of a tradition of registering births immediately after they occur. While this problem has lessened over time (Figueroa, 1998), it persists today. This method of estimation implicitly assumes that the number of births occurring in a given year that will be registered late in subsequent years is offset by the volume of late registrations in the current year of births from previous years.

Given that Mexico's population experienced rapid growth for most of the **20th century**, and consequently, the birth rate also increased significantly, for the hypothesis to be satisfactorily fulfilled, the proportion of late registrations for each generation would have to increase over time. This would compensate for the annual increase in births and also recover those births that death or international emigration prevented from being registered. Current trends do not show an increase significant enough to meet these conditions.

The compensation assumption was initially questioned by Benitez (1970): through a retrospective reconstruction of the census populations, using the mortality tables that he and Cabrera (1967) had prepared, he estimated that the births registered during the three-year period 1929-1931 underestimated those that occurred by more than 15%, in 1939-1941 by 10% and in 1949-1951 by 5%. A replication of the exercise, with our data from chapters 2 and 4, shows that the omission, during 1950-1971, varied from 0.7% in 1965 to 9.8% in 1952 if the retrospective is done with the populations counted in 1960, 1970 and 1980. ¹ Lailson (1980) applies various procedures to estimate the births that occurred between 1950 and 1975 and concludes that the number of registered births underestimates the number that occurred in the entire period.

As a result of the widespread acceptance of family planning in Mexico and the

¹ See chapter 5 for the retrospective procedure.

Given the decline in fertility, it is possible that in recent years births have barely increased or have even decreased, now that the inertia of past rapid growth in the female population of reproductive age has subsided. If this is the case, and assuming that the pattern of late registration remains unchanged over several generations, registered births now overestimate the actual number of births, since the volume of late registrations in the current year is greater than the number of births originating in that year that will be registered in the future. This is confirmed again by looking back at the censuses from 1980 to 2010: registered births exceed reconstructed births by more than 3.0%, with a maximum of 21% in 1994. Another bias in vital statistics that results in an overestimation of fertility levels comes from the probable—and apparently not insignificant—multiple registration of births, although it is not possible to know its magnitude precisely (Partida, et al., 2005: 57-68).

In this chapter we focus on reviewing the consistency of estimates of the level and age structure of fertility obtained from different sources and with diverse methodologies in order to propose plausible trends in the features of this demographic process over the last six and a half decades.

3.1 Vital statistics

Registered births are a powerful source for fertility estimates. Their main advantages are their universal coverage and the fact that the timing of births and the mother's age at delivery are not significantly distorted, since the information is almost always provided by the mother herself. The main shortcomings of this source are late registration, multiple registration, and the location of the mother's residence at the time of birth. We will discuss some aspects of late registration below, and the analysis of double registration will be covered in Chapter 7, where we present estimates for the states.

To determine the frequency of late registration, information on the year of occurrence and age at registration is used, both in the year the event takes place and in subsequent years. ^A first approach, by way of example, to the patterns of late registration is found in the reconstruction of births from the 1995, 2000, and 2005 cohorts in Table 3.1.

From the pregnancy histories of the National Survey of Demographic Dynamics (ENADID) of 1992 and 1997, the cumulative proportions of births registered up to 7 years of age were extracted, along with their 95% confidence intervals. Assuming that no child is registered more than once in the first year of life, we superimposed the ENADID distributions onto births registered before the first anniversary of vital statistics, that is, the age pattern of the first registration or, equivalently, those occurring after the age of registration. ³ From 3 years of age, the expected amount

² Data for the 1950-1983 generations were provided by Beatriz Figueroa for the work of Figueroa and Partida (1994) and supplemented with INEGI (1989, 1992) and the microdata databases of the civil registry from 1985 to 2015 available on the INEGI website. See Appendix E for a detailed description of the links to the different sources of information.

³ Note that, although it had been registered more than once, we only counted one child, the one

Registered up to age	Cohort 1995		Cohort 2000		Cohort 2005	
	Births accumulated	Percentage	Births accumulated	Percentage	Births accumulated	Percentage
0 years	2,063,451	80.34	2,085,250	81.92	1,937,681	82.53
1 year	2,246,879	87.48	2,253,837	88.55	2,096,576	89.30
2 years	2,337,995	91.03	2 344 202	92.10	2 183 132	92.99
3 years	2404 286	93.61	2 409010	94.64	2246 371	95.68
4 years	2,463,548	95.91	2,463,434	96.78	2291 393	97.60
5 years	2 513 284	97.85	2 502 951	98.33	2 318 435	98.75
6 years	2,543,118	99.01	2,522,947	99.12	2 331 916	99.33
7 years	2,556,411	99.53	2,533,299	99.52	2 339088	99.63
8 years	2,563,397	99.80	2 540 068	99.79	2 344074	99.84
9 years	2,568,508	100.00	2,545,394	100.00	2,347,729	100.00

Source: Vital Statistics 1995-2015

The number of registered individuals, in the 1977 to 1990 generations, exceeds the upper limit of the confidence interval, an excess that indicates the probable presence of multiple registrations (more than the maximum expected number of first-time registrations). Up to seven years of age, the smallest proportional excess over the upper limit of the confidence interval was 4.4%.

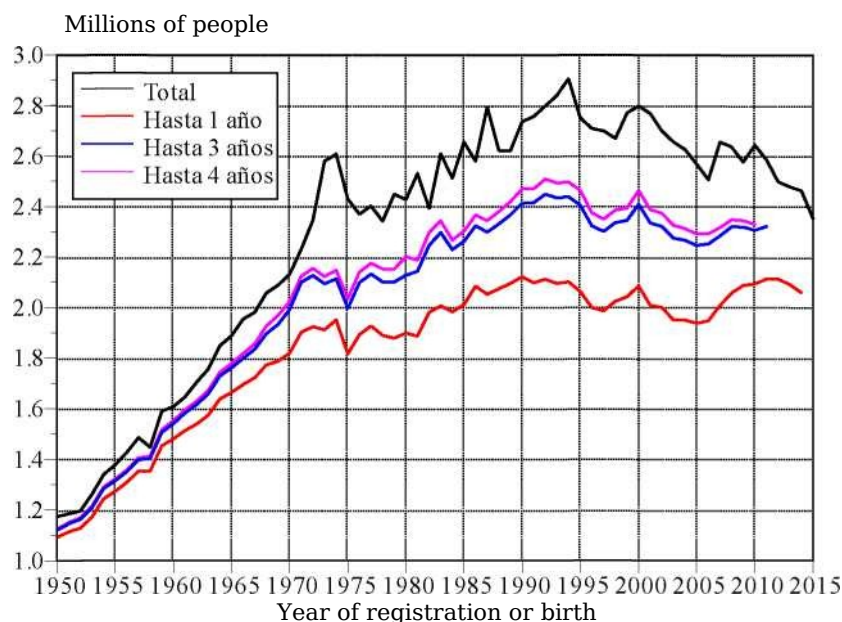
If only half, or two percent, of those born between 1977 and 1990 had obtained two or more birth certificates by 2015, then 98% or more of all births would have been registered—at least once—before the age of ten; indeed, all members of the 1983-1990 cohort would have been registered. Thus, we can assume that all births in each generation were registered before the tenth birthday.

The figures in Table 3.1 show that, in the 1995, 2000, and 2005 cohorts, over 80% of children were registered before their first birthday. One year later, 87% or more of births were registered, and an additional 4% were registered by their second birthday. By the time they should have entered primary school (age 6), over 99% had a birth certificate. Thus, the vast majority of births were registered either in the same year they were born or the following year, and by four years later, almost all children (at least 95%) had been registered.

Another way to investigate late registration is by using birth curves according to the year of occurrence and the different times parents take to register their children between 1950 and 2015—that is, the time frame we have established for demographic reconciliation. In Figure 3.1, we present an initial curve showing the total number of

the mother in the ENADID.

Figure 3.1. Total registered births and children up to four years of age for the



Source: Figueroa and Partida (1994) and Vital

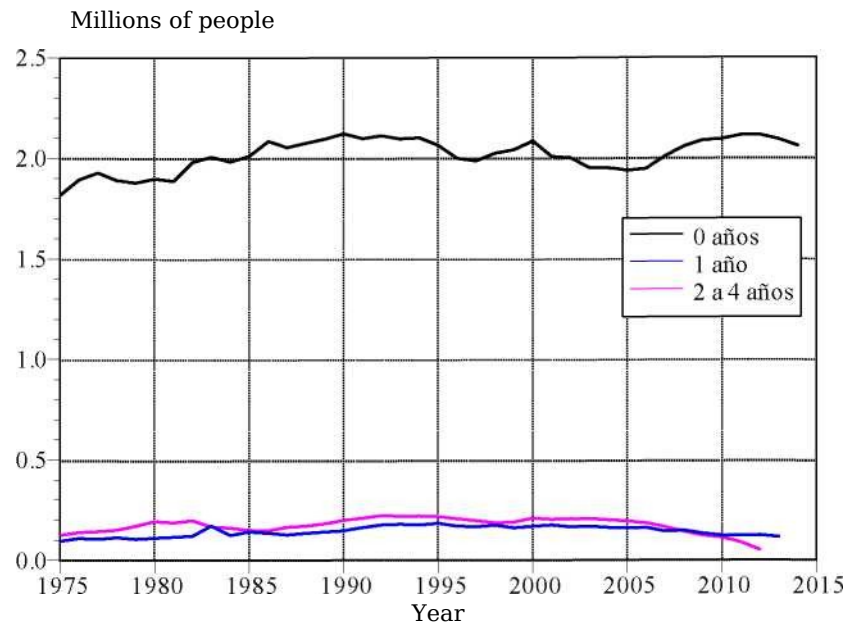
Reconstructed cohorts of births registered before the age of one, up to three and four years of age. The total number of registered births is significantly higher than the births in the individual cohorts, even those registered up to the age of four. Multiple registrations could be one explanation for this difference in the curve levels, most likely the case of the marked increase in 1973 and 1974 in response to a government campaign that encouraged the registration of births and marriages.

The trend in all cases is upward until the mid-1970s, and from then on, a slowdown in growth reflecting the new family planning policy. The decline in the total number of births, with some irregularities, over the last twenty years may indicate timely registration of births; however, the stability—also with fluctuations—of the time series of births shows that the decline in the total number of births is not primarily associated with a significant decrease in fertility. The increase in the year 2000 could be due to a genuine attraction to having a child in that year, or rather to an interest in registering children as having been born in the year that marks the beginning of the century; we will discuss this particularity again later.

The registration curve in the first year of life grows from 2005 to 2012, then declines in 2013 and 2014;⁴ but the rise stops sooner in those registered up to three and four.

⁴ We do not include the 2015 generation, as we do not yet have those who registered in 2016 before reaching one year of age. If we assume that the proportion of the 2014 cohort that registered at 0 years of age in 2015 is the same for the 2015 generation in 2016, the total number registered in the first year of life of the 2015 cohort would amount to 2,042,670, less than those registered of the 2014

Figure 3.2. Births registered according to year of occurrence and age at registration, 1975-2015



Source: Figueroa and Partida (1994) and Vital Statistics 1977-2015.

years of age. The earlier shift at later ages may indicate earlier birth registration. To clarify this issue, Figure 3.2 presents the number of births according to the year of occurrence and the age at registration, once the increase in the birth rate slowed.

The curve for the number of births registered in the first year of life shows a slight upward trend, with only minor fluctuations and the final decline noted above. Those registered between the first and second birthdays show a more stable trend, and the decline in the number of births registered between the ages of two and four begins in 2003. The trajectory of the three curves suggests that, starting in 2005, there was an improvement in the timing of registration: births were being registered earlier. This may be related to the implementation of the birth certificate program, which would encourage this earlier registration.

In graph 3.2 we can also investigate what happens with the increase in births in 2000. If the births that occurred in this year were more numerous than in the preceding years, this would be observed both in those registered in the first year of life and in the following four; however, only the births registered before the first anniversary show the increase in 2000. It would seem then that the births that occurred in that year, rather than being greater in number than in neighboring generations, were registered earlier, causing the increase in the curve.

Based on what we have presented regarding late registration and in order to avoid multiple registration as much as possible, in what follows, regarding fertility estimates

With this source, we will work with the reconstructed cohort series of births registered up to four years of age.

For a birth to be registered after delivery, the child must have survived and not emigrated. Since emigration in the first years of life is rare, we will assume that late registration is only conditional on survival. For the retrospective analysis from the time of registration to the time of birth, we use our estimates of infant and preschool mortality from Chapter 2.⁵ These estimates are reproduced in Table 3.2, along with those registered up to certain ages.⁶

3.2 The birth certificate

The birth certificate system was implemented in 2007, and the number of births by mother's age became public in 2008, although microdata databases are only available from 2009 onward. This certificate is issued by the institutions where the birth takes place. In some cases, births not attended by a healthcare institution can also obtain a certificate, but in others, they remain unrecorded. Since the vast majority of births in the country are attended by healthcare personnel or at a healthcare institution, the lack of coverage is not significant. However, the figures reveal a level below that derived from vital statistics and censuses, due to the lack of certificate coverage in some states, especially those where numerous births are not attended by medical, paramedical, or midwife personnel. The total number of certificates issued is included in Table 3.3.

3.3 The surveys

Pregnancy histories from sample fertility surveys have been the basis for estimating both fertility levels and timing in the country since the 1970s, when the first national fertility survey was conducted. Accurately reporting retrospective pregnancy histories provides a proper picture of fertility levels and their variations over time. However, pregnancy histories are often misreported, either due to the omission of events or their incorrect timing.

The first deficiency results in an underestimation of the fertility rate, while the second reflects a trend over time that differs from what actually occurred. This distortion can exhibit a pattern known as the Brass effect (1978), in which older women tend to exaggerate the interval between birth and the interview, resulting in an overestimation of the fertility rate for earlier periods and an underestimation for more recent periods. The inverse bias is noted by Potter (1975, 1977), who observes a tendency to place births closer to the survey date, but notes that immediate births are accurately reported.

⁵ See chapter 5 for the retrospective procedure.

⁶ For cohort reconstruction, in section 2.1.2, we used the births registered up to four years from table 3.2.

Year of occurrence	Registered up to the age of:			Occurred*	Year of occurrence	Registered up to the age of:			Occurrence*
	0 years	1 year	4 years			0 years	1 year	4 years	
1950	1,092,641	1 106,041	1,124,898	1,292,578	1983	20066	2,177,81	2,343,660	2,440,825
1951	1,113,126	1,129,145	1,150,167	1,322,628	1984	1,983,201	2,106,153	2,267,302	2,355,362
1952	1,126,171	1,145,190	1,167,214	1,328,828	1985	2,011,208	2,153,219	2,302,366	2,362,426
1953	1,171,243	1,190,265	1,214,290	1,389,568	1986	2,084,205	2,219,179	2,366,344	2,426,400
1954	1,243,973	1,265,800	1,290,842	1,451,304	1987	2,053,044	2,179,488	2,344,288	2,400,222
1955	1,273,365	1,296,953	1,321,741	1,478,323	1988	2,074,869	2,209,749	2,380,546	2,434,701
1956	1,308,130	1,330,741	1,357,741	1,510,193	1989	2,095,869	2,237,749	2,419,546	2,476,701
1957	1,353,135	1,376,741	1,405,741	1,556,748	1990	2,122,869	2,269,749	2,469,546	2,524,701
1958	1,354,135	1,379,741	1,412,741	1,557,958	1991	2,098,869	2,260,749	2,469,546	2,519,701
1959	1,453,261	1,479,882	1,516,812	1,667,928	1992	2,112,460	2,287,503	2,508,692	2,556,261
1960	1,480,110	1,510,235	1,552,262	1 702,312	1993	2,096,471	2,274,816	2,493,258	2,536,963
1961	1,513,153	1,548,235	1,595,262	1,745,048	1994	2,100,471	2,275,816	2,495,258	2,537,963
1962	1,539,157	1,579,235	1,629,262	1,778,488	1995	2,063,471	2,246,816	2,463,258	2,503,963
1963	1,574,157	1,617,235	1,672,262	1,819,658	1996	1,998,471	2,168,816	2,374,258	2,410,963
1964	1,638,302	1,685,898	1,744,050	1 893,247	1997	1,986,363	2,152,742	2,349,076	2,381,805
1965	1,663,916	1,715,700	1,778,181	1,925,985	1998	2,024,576	2 199,022	2,384,981	2,415,970
1966	1,695,172	1,749,780	1,817,856	1,964,968	1999	2,041,708	2 203,022	2,392,981	2 421,970
1967	1,722,177	1,780,836	1,856,927	2,002,207	2000	2,085,708	2,253,022	2,463,981	2,492,970
1968	1,773,177	1,836,836	1,927,927	2,074,188	2001	2,090,708	2,184,022	2,387,981	2,413,970
1969	1,787,779	1,857,916	1,968,911	2,112,534	2002	2,000,795	2,166,911	2,373,617	2,396,417
1970	1 820,794	1,896,888	2,023,676	2,173,865	2003	1,951,795	2,119,911	2,325,617	2,347,417
1971	1 902,794	20031,888	2,124,676	2,268,695	2004	1,950,790	2,112,606	2,312,954	2 332,586
1972	1,924,794	2,044,888	2,155,676	2,297,695	2005	1,937,790	2,096,606	2,291,954	2 308,586
1973	1,947,794	2,072,888	2,183,676	2 258,708	2006	1,947,790	2,108,606	2,292,954	2 308,586
1974	1,957,794	2,085,888	2,197,676	2,280,538	2007	2,085,790	2,151,606	2,316,954	2 331,586
1975	1,816,734	1 911,550	2,036,403	2,158,434	2008	2,057,403	2 205,482	2,347,692	2,362,148
1976	1,892,734	2 002,550	2,140,403	2,264,924	2009	2,088,403	2 221,482	2,343,692	2 353,148
1977	1,927,734	2,032,550	2,175,403	2,297,514	2010	2,093,403	2,216,482	2,330,692	2,344,148
1978	1,889,710	2,028,78	2,153,292	2,269,373	2011	2,112,901	2 234,098	2,330,692	2,355,590
1979	1,878,710	1,983,78	2,152,292	2,263,843	2012	2 114,901	2,237,098	2,330,692	2,356,590
1980	1 898,840	20087,038	2 201,842	2 309,538	2013	2,092,901	2,207,775	2,317,451	2,317,451
1981	1,886,840	2,018,038	2,187,842	2,289,878	2014	2,061,901	2,150,775	2,280,451	2,280,451
1982	1,980,569	2,100,443	2,297,291	2,398,384	2015	2,061,901	2,150,775	2,280,451	2,256,862

* Retrospective registration at the time of birth (see Annex E for the 2011-2015

This pattern fosters a tendency for fertility levels to be underestimated in earlier periods of the survey, overestimated in subsequent years, and underestimated in the immediate period, leading to the erroneous conclusion that fertility has declined in recent years or that the decline has been more pronounced. The evaluation of these surveys has been the subject of various studies (Ordorica and Potter, 1981; Partida et al., 2005) that conclude that, with certain distortions (which are not always the same), pregnancy history data are useful for obtaining plausible estimates of fertility in the country.

However, several studies have indicated that the levels revealed by surveys are lower than the actual levels. The publication of the **2010 census data** confirmed that the fertility levels used in official demographic estimates (Partida, 2008) were underestimated.

3.4 Population censuses

There are several ways to obtain fertility estimates from population census data between 1990 and 2015. Information on the date of birth of the last live birth in the 2000 and 2010 censuses and the 2015 intercensal survey allows us to determine the number of births that occurred in the year prior to the census. Furthermore, the same census provides the female population, which serves as the denominator for calculating age-specific rates. This information has the advantage that in the year prior to the census, the vast majority of births correspond to the last children, thus providing a good approximation of the total births for the year.⁷ The number of births was 2.36 million in 1999, 2.40 million from June 2009 to May 2010, and 2.21 million in 2014.

The quality of the data on the birth date of the last live-born child in the 2000, 2010, and 2015 enumerations is reasonable. Non-response regarding the year of birth was only 2.7% among women aged 15–49 in 2000, 1.2% in 2010, and 1.0% in 2015.

Another way to obtain fertility moment estimates using census data is through retrospective analysis of the census population under 15 years of age, classified by individual ages and the individual ages of their mothers.⁸ Mortality estimates from Chapter 2 and international migration estimates from Chapter 4 were incorporated into all three censuses and the survey.

⁷ The possible underestimation comes from multiple births, since only one birth is considered in the numerator of the rate.

⁸ If the emancipation of children from the parental home is only considered significant from the age of 15, the absence from the home of offspring under 15 years of age must be minimal.

3.5 The different estimates of births

Table 3.3 compares the different birth series obtained from vital statistics, population enumerations, and birth certificates. We have already mentioned the levels and trends obtained from vital statistics. Here, ^{we} want to examine the similarities and differences between the different estimates, using as a frame of reference the estimates derived from vital records, which are reproduced in the first column of Table 3.3.

In general, proportional deviations are less than 10%, except for the amounts derived from the retrospective count of children and adolescents for the two or three years immediately preceding the census or survey, when their values are very low (underestimation greater than 10%) due to the undercounting of children under three years of age in population counts.

It should be noted that, except for 1975-1977, 1979, and 1981 (with the retrospective analysis of the population counted in the 1990 census), 1999 (from the 2010 census), and the last child born in 2010, in all other cases the estimate of births based on vital statistics is higher. This suggests that the series of births registered up to four years later and *traced back* to the time of delivery is a good approximation of births occurring in the year, and that the number of births obtained using data on the birth date of the last live birth in the two censuses and the intercensal survey constitutes plausible estimates of the birth rate for the period. Furthermore, we chose to retain birth certificates for the seven years and, subsequently, when disaggregating them by the mother's age, select the years that are consistent with the other data sources.

3.6 Estimates of age-specific fertility rates

Our main objective is to estimate age-specific fertility rates, as they constitute an essential piece of information, along with mortality and migration, for demographic reconciliation, as explained in Chapter 5. For the selection, we used fertility rates derived from the following data sources:

1. Pregnancy stories from the *Mexican Fertility Survey* (EMF) 1976-1977; *National Fertility and Health* (ENFES) of 1987 and National *Demographic Dynamics* (ENADID) of 1992, 1997, 2006, 2009 and 2014;
2. Births registered up to 4 years of age located at the time of delivery with the probabilities of survival;
3. Last child born and recorded in the 2000 and 2010 censuses and in the *Intercensal Survey 2015*;

⁹ The series begins in 1975, since in that year the quantifications other than vital statistics begin.

Table 3.3. Births from vital records, population enumerations and birth certificates, 1975-2015

Year of occurrence	Occurred *	Own children Last child Certificate of			
		1990 Census	2000 Census	2010 Census	2015 Survey
1975	2,158,434	2,359,952			
1976	2,264,922	2,284,165			
1977	2,297,515	2,404,677			
1978	2,269,373	2,119,677			
1979	2,263,845	2,360,830			
1980	2 309 731	2,227,823			
1981	2,289,872	2,362,446			
1982	2,398,384	2 241 210			
1983	2,440,825	2,256,452			
1984	2,355,856	2 245 767			
1985	2,362,638	2,307,744	2,318,990		
1986	2,426,299	2 276 080	2 302 642		
1987	2 400 222	2,147,676	2,378,809		
1988	2,434,791	1,925,515	2,262,583		
1989	2,476,246	1 983 106	2 430 092		
1990	2 524 095		2,374,361		
1991	2,519,282		2,410,884		
1992	2,556,261		2 361 147		
1993	2,536,963		2,350,308		
1994	2,537,835		2,355,164		
1995	2,503,776		2 371 462	2 341 077	

		2 251 026 2 254			
1996	2 410 144	465			
1997	2 381 805	2,169,983			
1998	2,415,970	2 079 060 2 215			
1999	2 421 801	2 101 333 2 459		2,363,270	
2000	2,492,730	2,363,904	2,452,171		
			2,284,994		
2001	2,413,697	2,291,720	4		
2002	2,396,417	2,245,885	2,336,365		
2003	2,347,586	2 239 473	2 220		
2004	2 332 111	2,225,459	4 377		
2005	2 308 284	2,217,328	2,317,875		
			2,191,600		
2006	2 308 039	2 207 112	2,296,290		
2007	2 331 624	2,195,565	2 274		
2008	2,362,148	2,077,635	2,271,641		
2009	2 353 305	2,053,405	2,247,563	2,400,880	2,046,232
2010	2,344,466		2,257,722		2,063,539
			2		
2011	2,355,590		2 235		2,142,629
2012	2,356,451		165		2,197,328
			2,186,485		
2013	2,317,390		2,049,465		2,189,257
2014	2,280,357		2,033,291	2,208,585	2,173,772
2015	2,256,862				2,143,338

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* Retrospective registration to the time of birth (see Annex E for the 2011-2015 generations).

•f Refers to the period from June 1, 2009 to May 31, 2010.

Source: Table 3.2, population censuses of 1990, 2000 and 2010, population count of 2005, intercensal survey of 2015 and

4. Birth certificate from 2009 to 2015.

The rates corresponding to each of the seven five-year groups of fertile ages and the total fertility rate (TFR) are reproduced in Annex E and in Figure 3.3.

Some clarifications regarding the calculation of age-specific fertility rates are necessary. For both births recorded in the census and those from birth certificates, the estimated female populations from Chapter 2 were used as denominators. The number of children born in the last census was divided by the number of women listed in the corresponding censuses and the intercensal survey. Finally, for pregnancy histories, the person-years lived by all women were used as the denominator. Rates were calculated by dividing the number of births in a three-year period by the person-years lived during that same period, and the rate for the three-year period was assigned to the intervening year.¹⁰

A visual inspection of the panels in Figure 3.3, corresponding to the four five-year age groups (20-39 years), shows a clear proximity in the rates of the ten data sources considered, except for minimal deviations from the identifiable temporal trend. In the last two five-year age groups, the scarcity of rates, except for those derived from vital records, provides little information for before 1990, although more abundant data is available for the 40-44 age group over the last five five-year periods. The 15-19 age group has the most data, but the disparity between sources is more pronounced than in the other six age groups, although a clear decrease over time is observed. In the 20-39 age group, selecting the observations for the final estimate presented no major difficulty, as removing the few rates that deviated from the trend was straightforward. And at the end of the fertile period, the pattern of rates derived from vital statistics as a reference simplified the selection. In the 15-19 age group, however, the selection was somewhat arbitrary, although the range encompassed by most of the observations facilitated the selection. The periods chosen for the final estimate are detailed in Table 3.4.

Once the rates were selected, the arithmetic mean of the chosen rates was taken for each calendar year and fertile age group. In order to remove some minor irregularities, the temporal trend of each interval was smoothed using the robust *lowess procedure* of the STATA software package (2003), using a window of 20% of the observations for maternal age 15-19, 10% for 20-24, 15% for 25-29, 30-34, 35-39, and 45-49, and 18% for 40-44. The average of the selected observations and their smoothing are reproduced in Figure 3.4.

As a point of reference for analyzing the different rates of decline in estimated fertility in recent years, Figure 3.5 presents the proportion of women in unions

¹⁰ For example, the period 1977-1979 was fixed in 1978, 1978-1980 in 1979, 1979-1981 in 1982, and so on. Rates were only selected when the age range of the mid-year period coincided completely with the corresponding conventional five-year group. Let's take as an example the 25-29 age group for the period 1989-1991, and assume that the oldest cohort in the survey was born in 1960. In 1989, births and person-years for completed 25-28 and 29 years are used only for those born in 1960, since we do not have figures for 29 years for those born in 1959. The figures for 25-29 years in 1990 and 1991 are taken in full. The three-year sums of births and person-years correspond to the numerator and denominator, respectively, of the 25-29 year fertility rate of 1990.

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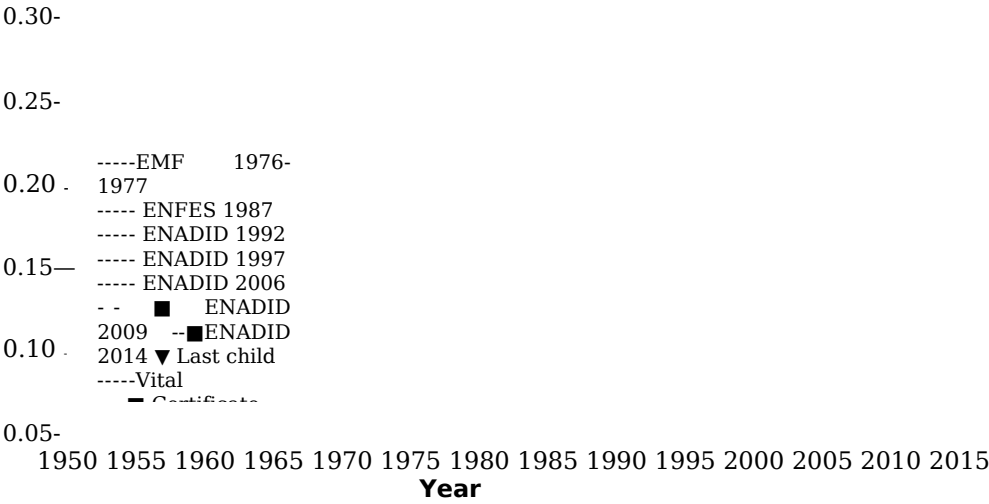


Figure 3.3.

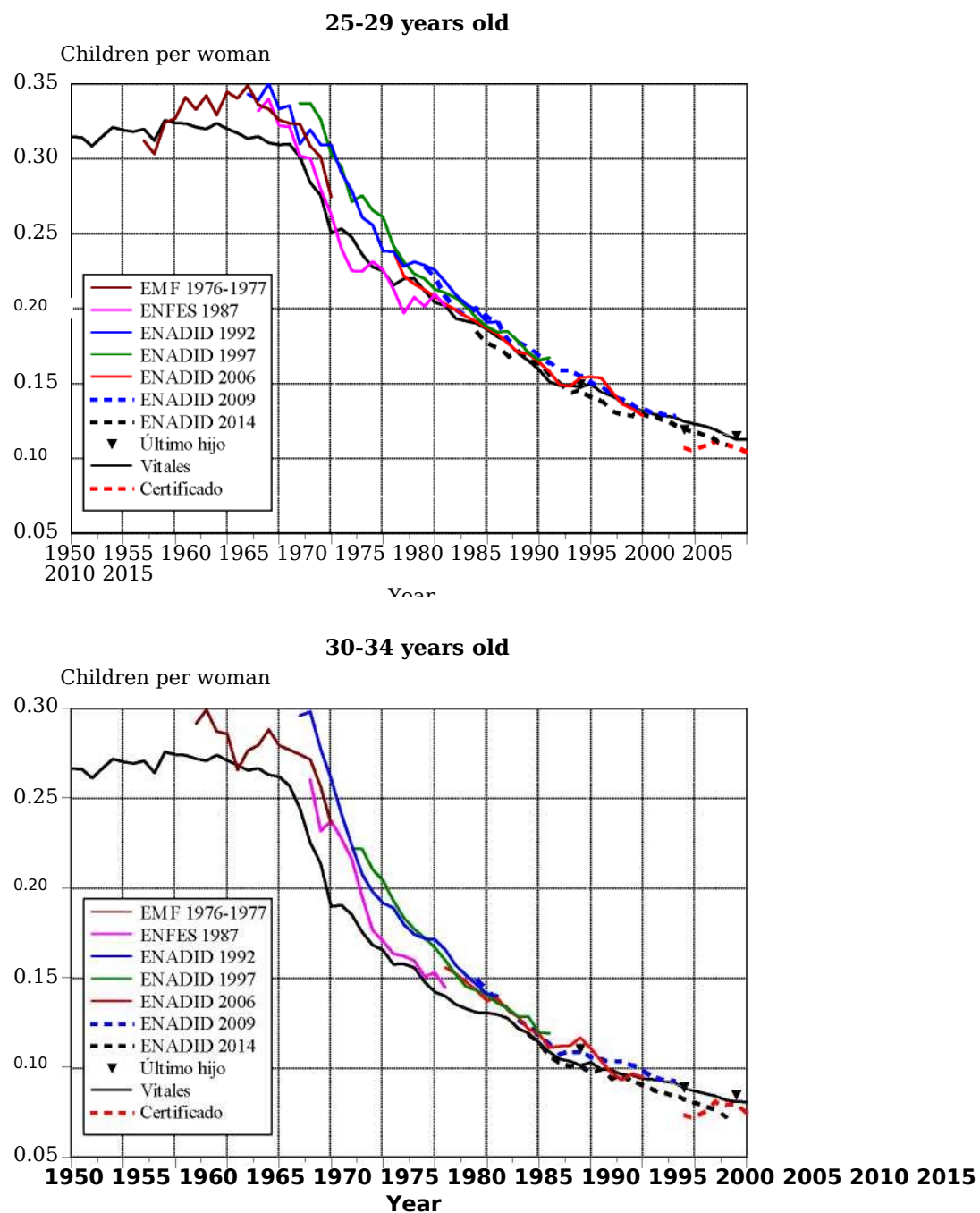
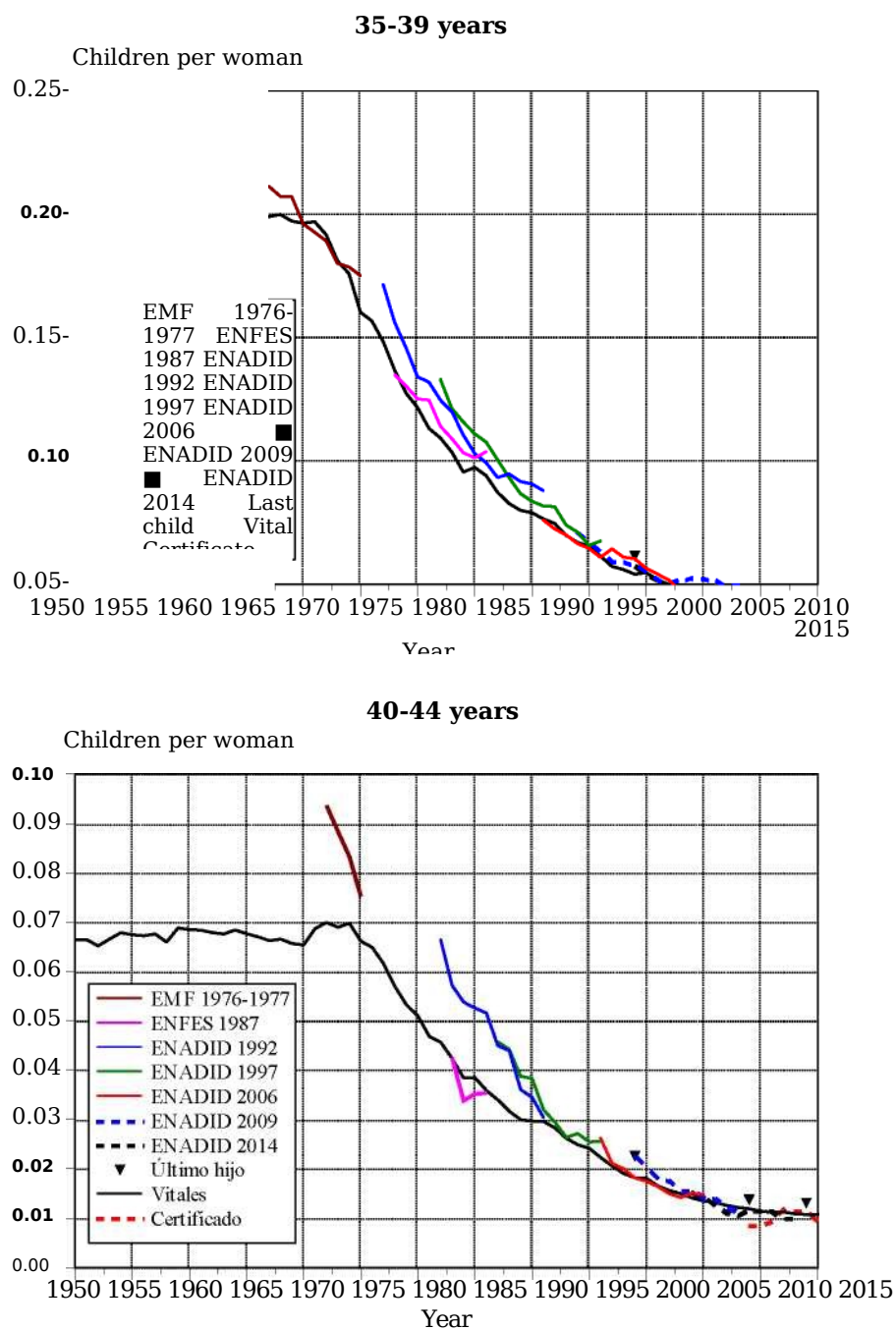
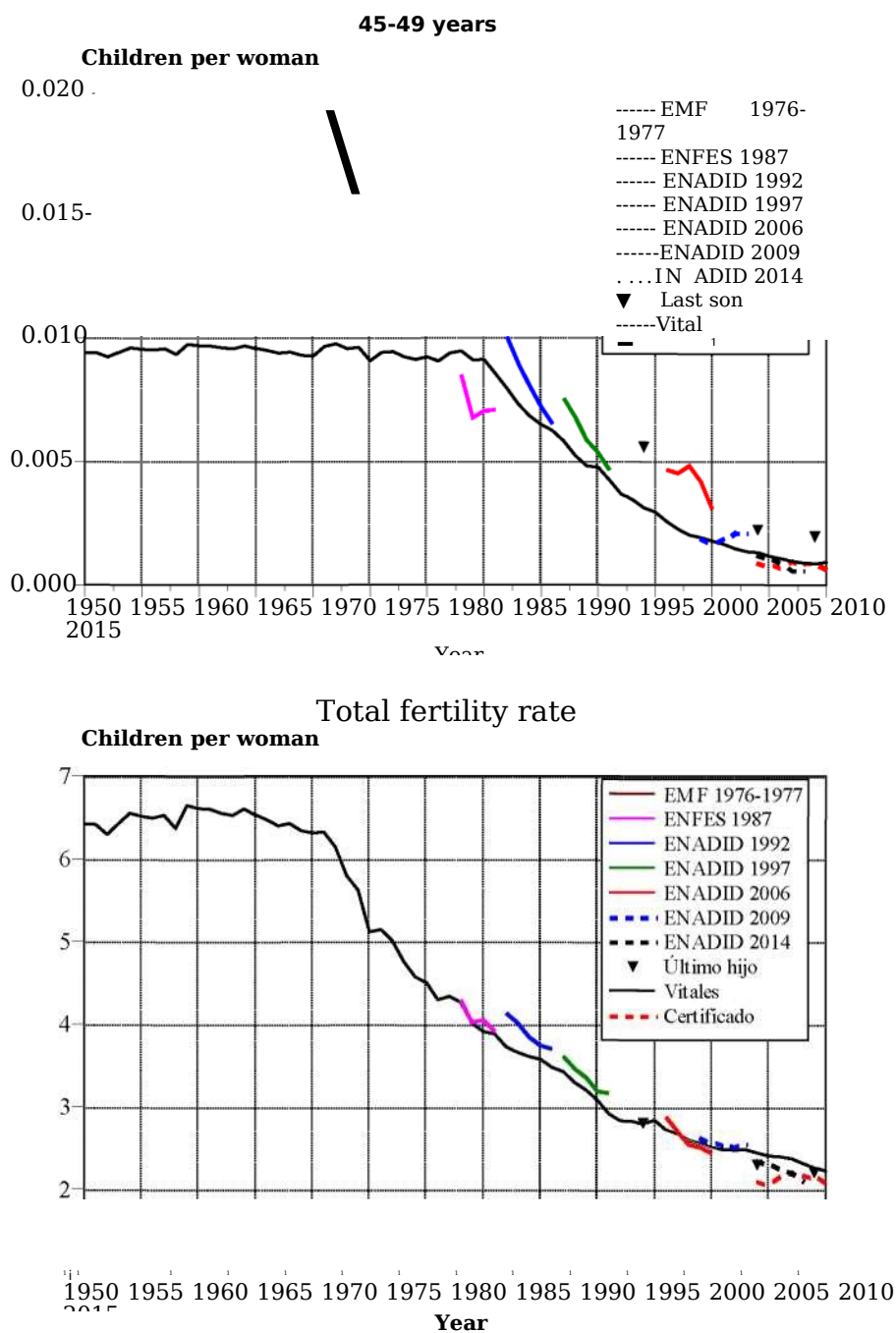


Figure 3.3.



**Figure
3.3.**



Source: Pregnancy histories from fertility surveys, 2000 and 2010 censuses, 2015 intercensal survey, vital statistics 1950-2015 and

Data source ■	Mother's age group						
	15-19	20-24	25-29	30-34	35-39	40-44	45-49
EMF 1976-1977	1950-1970	1952-1975	1957-1975	1962-1975	1967-1975		
ENFES 1987	1968-1986	1963-1986	1968-1986	1973-1986	1978-1986	1983 and 1985-1986	
ENADID 1992	1967-1991	1962-1991	1967-1991	1974-1991	1977-1991	1991	1991
ENADID 97	1966-1996	1967-1996	1972-1996	1977-1996	1982-1996	1991-19%	1995-19%
ENADID 06	1980-2003	1976-2005	1981-2005	1986-2005	1991-2005	1996-2005	
ENADID 09	1980-2008	1979-2008	1984-2008	1989-2008	1994-2008	1999-2008	2004-2008
ENADID 14	1982-2013	1984-2013	1989-2013	1994-2013	1999-2013	2004-2013	2009-2013
Last son		1990-2015	1990-2015	1990-2015	1990-2015	1990-2015	2000-2015
Vital	1966-2015	1950-2015	1950-2015	1950-2015	1950-2015	1950-2015	1950-2015
Certificate	2009-2011 and 2015	2012-2015	2012-2015	2012-2015	2011-2015	2009-2015	2009-2015

Source: Pregnancy histories from fertility surveys, 2000 and 2010 censuses, 2015 intercensal survey, vital statistics 1950-2015 and birth certificate.

Among women of reproductive age who reported using some form of contraception at the time of the survey, it was observed that use was infrequent in 1987; only slightly more than half of women in unions were using contraception. Five years later, use increased by more than 10 percentage points. From 1997 onward, the increases became less pronounced, while between 2006 and 2009 the proportion of users increased by only 1.6%, and in 2014 there was only a slight decrease over the five-year period, with almost three out of four women in unions using contraception between 2009 and 2014.

Age-specific rates for selected years, which we consider best represent the fertility transition in Mexico, are presented in Table 3.5 and Figure 3.6. Before the explicit family planning policy adopted by the Mexican government in the mid-1970s, large numbers of children were born well into the fertile period, exhibiting a late-peak age composition.

The response to family planning campaigns was a concentration of offspring—increasingly smaller—at younger reproductive ages, which brought with it a progressive modification of the fertility calendar towards an early peak pattern, as can be seen in the age rates from 1980 onwards in Table 3.5 and Graph 3.6.

Figure 3.4. Age-specific fertility rates from average and smoothed pregnancy histories and

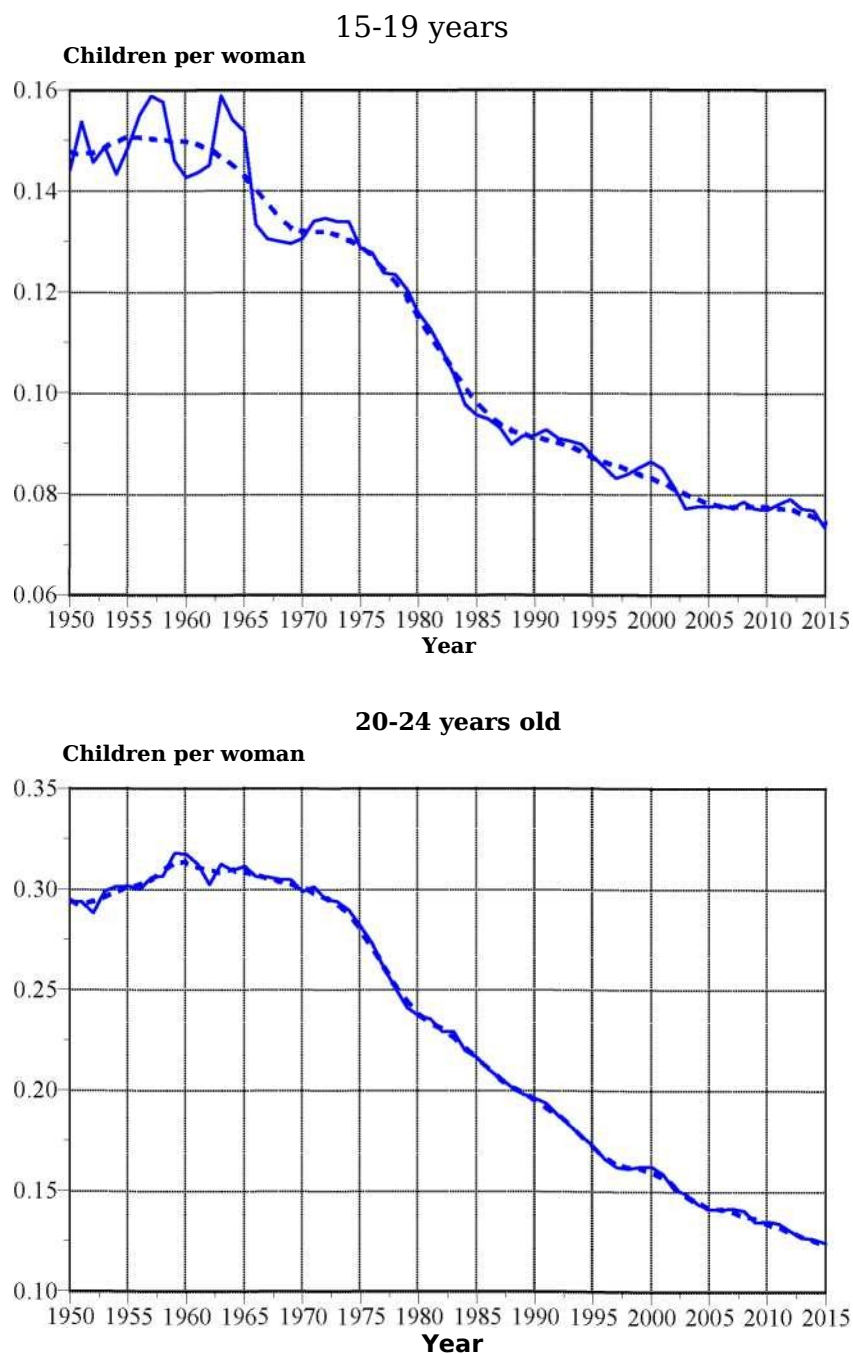
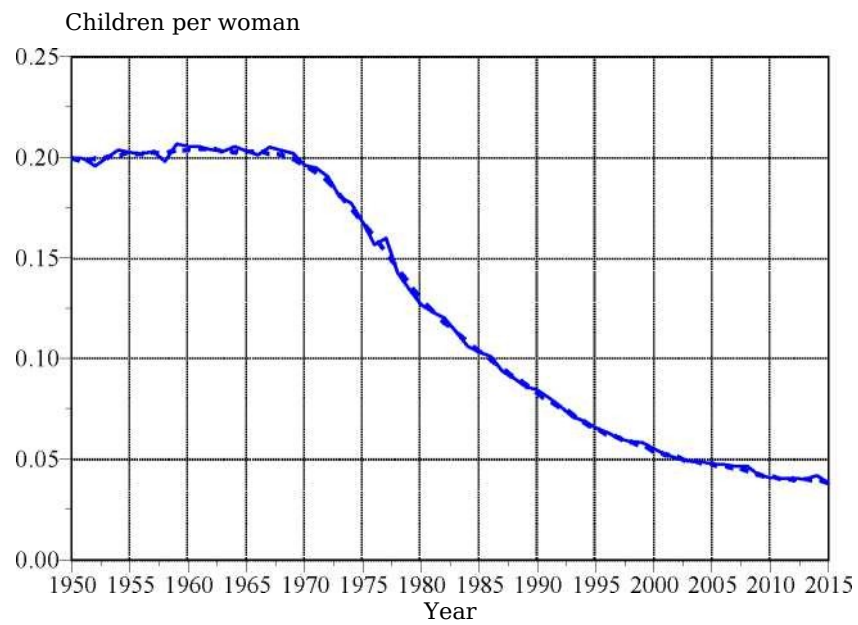


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3.4.

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40-44 years

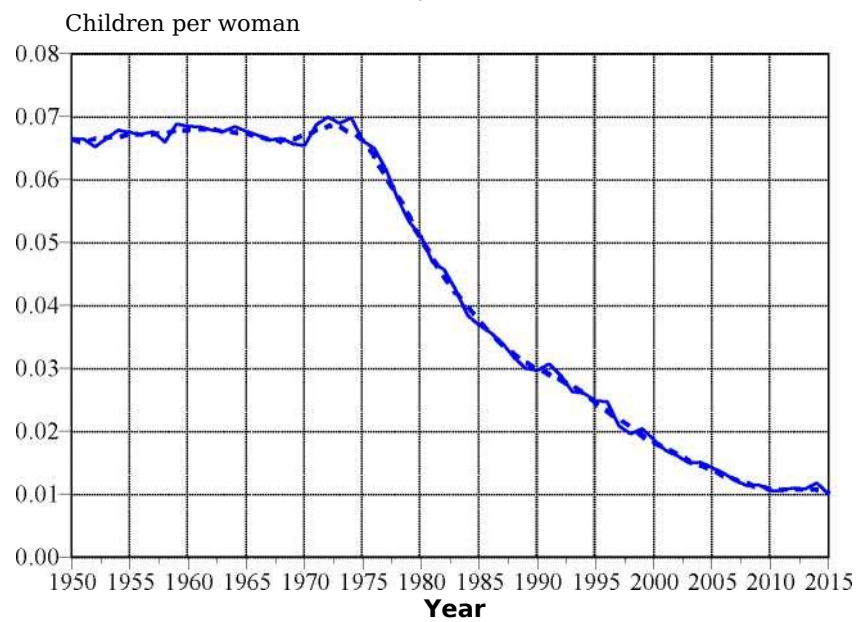
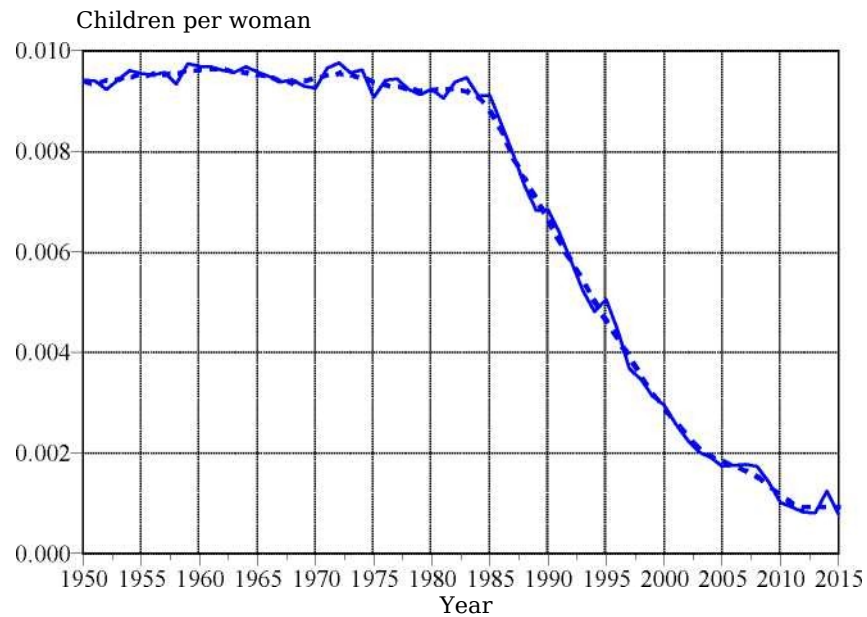


Figure 3.4.
(Concludes)

45-49 years

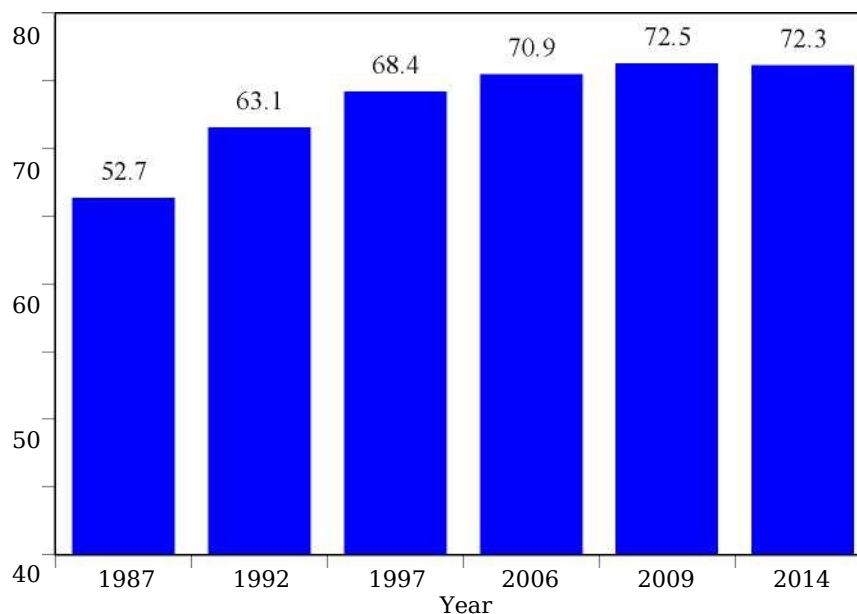


Total fertility rate

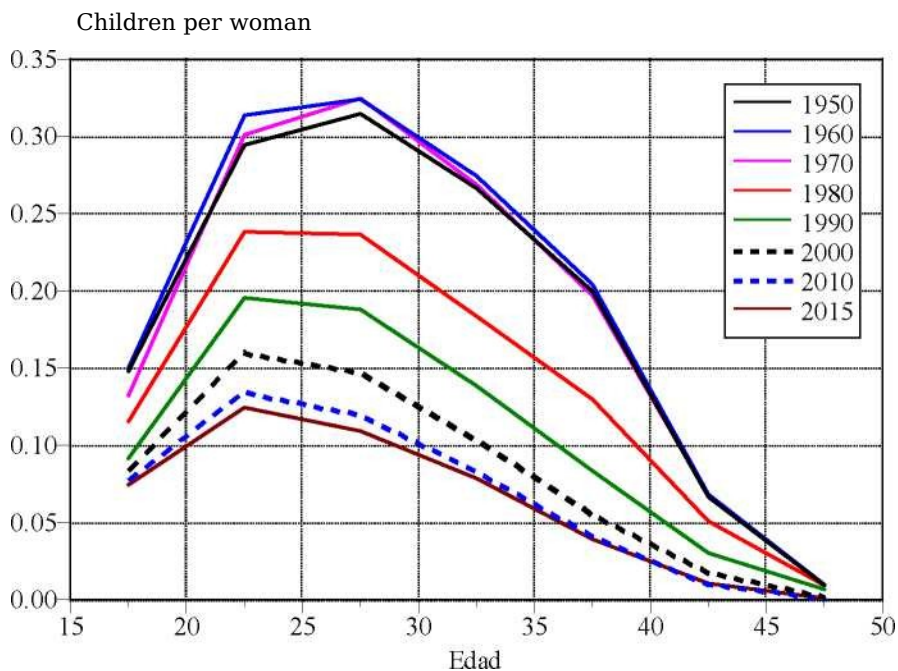


Source: Same as in graph 3.3.

Figure 3.5. Percentage of women in unions of childbearing age who use contraceptive methods, 1987-2014



Geáfca 3.6. Definitive age-specific fertility rates for selected years



Source: Table 3.5.

occurrence	15-19	20-24	25-29	30-34	35-39	40-44	45-49	TGF*
1950	0.147 ⁸⁴	0.294 ³³	0.314 ⁵⁴	0.266 ³⁸	0.199 ⁶¹	0.066 ⁵⁴	0.0094 ¹	6.49
1951	0.147 ⁶¹	0.292 ⁶⁴	0.313 ¹²	0.265 ¹⁷	0.198 ⁷⁰	0.066 ²³	0.0093 ⁷	6.46
1952	0.147 ⁷³	0.294 ¹¹	0.314 ⁰³	0.265 ⁸⁴	0.199 ²⁸	0.066 ⁴³	0.0094 ⁰	6.48
1953	0.148 ⁶⁷	0.296 ⁴³	0.315 ²⁹	0.267 ⁰¹	0.200 ⁰⁸	0.066 ⁶⁹	0.0094 ⁴	6.52
1954	0.149 ⁹⁴	0.299 ²³	0.316 ⁴⁴	0.268 ¹²	0.200 ⁹¹	0.066 ⁹⁷	0.0094 ⁸	6.56
1955	0.150 ⁷⁰	0.301 ¹⁵	0.317 ¹¹	0.269 ¹⁸	0.201 ⁷¹	0.067 ²⁴	0.0095 ¹	6.58
1956	0.150 ⁷⁸	0.302 ⁵⁵	0.316 ⁷³	0.269 ⁴⁷	0.201 ⁰³	0.067 ³¹	0.0095 ²	6.59
1957	0.150 ⁵³	0.305 ¹⁸	0.316 ⁸⁴	0.269 ⁸⁵	0.202 ⁰	0.067 ⁴⁰	0.0095 ⁴	6.61
1958	0.150 ⁷²	0.309 ⁶⁰	0.318 ²⁸	0.270 ⁶⁸	0.202 ⁸³	0.067 ⁶¹	0.0095 ⁷	6.64
1959	0.150 ¹²	0.313 ⁰¹	0.320 ⁸²	0.271 ⁹⁶	0.203 ⁴⁸	0.067 ⁸³	0.0096 ⁰	6.68
1960	0.149 ⁹⁶	0.313 ⁵⁷	0.324 ⁰¹	0.274 ³²	0.204 ⁰⁵	0.068 ⁰²	0.0096 ²	6.72
1961	0.149 ⁴⁷	0.311 ⁵⁷	0.327 ⁰⁶	0.277 ²⁷	0.204 ⁴⁸	0.068 ¹⁶	0.0096 ⁴	6.74
1962	0.148 ⁴⁷	0.309 ⁶²	0.328 ⁵⁴	0.279 ⁰⁴	0.204 ³⁸	0.068 ¹³	0.0096 ⁴	6.74
1963	0.146 ⁸²	0.308 ⁸³	0.329 ¹⁰	0.279 ⁵⁵	0.203 ⁰⁰	0.067 ⁰⁷	0.0096 ²	6.73
1964	0.145 ¹⁷	0.309 ⁵³	0.329 ⁴²	0.278 ⁴⁶	0.203 ⁴⁵	0.067 ⁷³	0.0095 ⁸	6.72
1965	0.143 ⁰⁵	0.309 ⁰⁰	0.330 ¹¹	0.276 ²¹	0.203 ³⁸	0.067 ⁴⁵	0.0095 ⁴	6.69
1966	0.140 ⁴⁴	0.307 ⁵⁷	0.330 ⁸³	0.274 ⁰⁴	0.203 ²²	0.067 ¹¹	0.0095 ⁰	6.66
1967	0.137 ⁵¹	0.306 ⁰⁸	0.331 ¹⁶	0.272 ⁶⁴	0.202 ⁷⁶	0.066 ⁶⁶	0.0094 ³	6.63
1968	0.134 ⁷⁷	0.304 ⁵¹	0.330 ²⁵	0.271 ⁸¹	0.201 ⁶⁴	0.066 ³⁶	0.0093 ⁰	6.59
1969	0.132 ⁹³	0.302 ⁸³	0.328 ¹⁵	0.270 ⁹⁹	0.199 ⁸⁸	0.066 ⁵⁶	0.0094 ⁰	6.55
1970	0.132 ¹⁶	0.300 ⁹⁴	0.324 ⁶⁴	0.268 ⁷²	0.196 ⁹¹	0.067 ¹⁵	0.0094 ⁶	6.50
1971	0.132 ⁰⁷	0.298 ⁴⁰	0.319 ⁸²	0.264 ⁴⁴	0.192 ⁶⁵	0.067 ⁸⁴	0.00951 ⁰	6.42
1972	0.131 ⁰⁸	0.295 ⁰⁴	0.313 ²⁵	0.258 ³⁰	0.187 ⁶⁰	0.068 ⁴⁸	0.0095 ⁵	6.33
1973	0.131 ⁵⁰	0.292 ³⁵	0.304 ⁶⁰	0.250 ⁴⁴	0.181 ⁶¹	0.068 ⁵⁸	0.0095 ³	6.19
1974	0.130 ⁵⁷	0.287 ²⁸	0.294 ²²	0.241 ³¹	0.174 ⁷⁶	0.067 ⁸¹	0.0094 ⁸	6.03
1975	0.129 ⁰⁹	0.280 ³⁵	0.282 ⁴⁶	0.231 ⁴⁸	0.167 ⁸⁸	0.066 ¹⁷	0.00941 ⁰	5.83
1976	0.127 ⁰⁶	0.271 ³¹	0.270 ⁶²	0.220 ⁰⁸	0.160 ⁴⁷	0.063 ⁷²	0.0093 ⁴	5.62
1977	0.124 ⁵⁸	0.261 ³¹	0.260 ¹¹	0.210 ²⁹	0.152 ³³	0.060 ⁶⁷	0.0092 ⁰	5.39
1978	0.121 ⁷⁶	0.251 ⁵⁸	0.251 ³⁰	0.200 ⁴²	0.144 ³⁵	0.057 ³⁹	0.0092 ⁶	5.18
1979	0.118 ⁶⁶	0.243 ⁸²	0.243 ⁵⁰	0.191 ⁴⁹	0.136 ⁸²	0.053 ⁹⁹	0.00923 ⁰	4.99
1980	0.115 ²⁸	0.238 ¹⁴	0.236 ⁴²	0.183 ⁵²	0.129 ⁶⁸	0.050 ⁷⁷	0.00921 ⁴	4.82
1981	0.111 ⁶⁴	0.234 ⁰⁹	0.230 ¹²	0.176 ⁸²	0.123 ⁵⁴	0.047 ⁸⁰	0.00923 ⁴	4.67
1982	0.107 ⁰⁴	0.230 ⁵²	0.224 ⁵⁵	0.171 ²⁰	0.118 ¹²	0.044 ⁰⁰	0.0092 ⁴	4.53

occurrence	15-19	20-24	25-29	30-34	35-39	40-44	45-49	TGF*
	0.104	0.225	0.219	0.166	0.113	0.042	0.0092	
1983	32	97	73	22	19	16	1	4.40
1984	0.100	0.221	0.215	0.161	0.108	0.039	0.0090	4.28
1985	95	14	56	65	41	72	8	4.16
	0.097	0.215	0.211	0.157	0.103	0.037	0.0088	
1986	90	76	58	25	52	45	1	4.05
	0.095	0.210	0.207	0.152	0.098	0.035	0.0084	
1987	50	65	18	80	82	41	0	3.94
	0.093	0.206	0.202	0.149	0.094	0.033	0.0079	
	87	05	33	06	78	68	4	
	0.092	0.201	0.197	0.145	0.090	0.032	0.0074	
1988	75	95	37	34	83	25	8	3.84
	0.092	0.198	0.192	0.141	0.086	0.031	0.0070	
1989	02	60	60	84	88	12	5	3.75
1990	0.091	0.195	0.187	0.138	0.083	0.030	0.0066	3.67
	45	43	85	37	32	15	4	
1991	0.090	0.191	0.183	0.134	0.079	0.029	0.0062	3.58
1992	02	80	06	71	60	21	2	3.48
	0.090	0.187	0.178	0.130	0.076	0.028	0.0058	
	31	44	30	72	04	29	2	
	0.089	0.182	0.173	0.126	0.072	0.027	0.0054	
1993	49	44	56	30	41	26	4	3.38
	0.088	0.177	0.168	0.121	0.068	0.026	0.0050	
1994	47	22	65	54	86	02	6	3.28
1995	0.087	0.171	0.163	0.116	0.065	0.024	0.0046	3.18
1996	42	06	64	86	81	62	7	3.08
	0.086	0.167	0.158	0.112	0.063	0.023	0.0043	
1997	54	22	06	82	32	26	0	3.01
	0.085	0.163	0.155	0.109	0.061	0.0220	0.0039	
	79	78	06	69	12	1	2	
	0.085	0.162	0.151	0.107	0.059	0.020	0.0035	
1998	03	09	97	28	04	72	3	2.95
	0.084	0.161	0.149	0.105	0.056	0.019	0.0031	
1999	14	41	44	21	86	42	8	2.90
	0.083	0.159	0.147	0.103	0.054	0.018	0.0028	
2000	10	02	01	48	02	36	7	2.85
	0.082	0.156	0.144	0.101	0.052	0.017	0.0025	
2001	25	85	13	51	04	36	8	2.79
2002	0.081	0.152	0.140	0.099	0.051	0.016	0.0023	2.72
	28	67	67	42	09	36	4	
	0.080	0.148	0.137	0.097	0.049	0.015		
2003	23	18	08	44	64	48	0.00211	2.65
2004	0.079	0.144	0.133	0.095	0.048	0.014	0.0019	2.59
	18	74	04	60	61	72	4	
2005	0.078	0.142	0.131	0.094	0.047	0.013	0.0018	2.55
	30	40	54	14	86	07	4	
2006	0.077	0.141	0.129	0.092	0.047	0.013	0.0017	2.52
2007	72	28	54	56	12	21	7	2.48
	0.077	0.140	0.127	0.090	0.046	0.012	0.0016	
	51	23	44	70	04	46	8	
	0.077	0.138	0.125	0.088	0.044	0.011	0.0015	
2008	53	57	27	58	65	77	4	2.44
	0.077	0.136	0.122	0.086	0.043	0.011	0.0013	
2009	58	60	05	28	24	25	7	2.40
	0.077	0.134	0.120	0.083	0.041	0.010	0.0011	2.35
2010	52	50	28	08	02	07	7	
2011	0.077	0.132	0.117	0.081	0.040	0.010	0.00102	2.31
	30	55	58	94	95	88		
	0.076	0.130	0.115	0.080	0.040	0.010	0.0009	
2012	95	35	26	54	52	88	5	2.28
	0.076	0.127	0.112	0.079	0.040	0.010		
2013	48	08	04	61	24	87	0.00093	2.25
	0.075	0.125	0.110	0.079	0.039	0.010	0.00093	2.21
2014	72	00	72	04	86	70		
2015	0.074	0.124	0.109	0.078	0.039	0.010	0.00093	2.18
	20	25	00	54	14	47		

* Total fertility rate

Source: Pregnancy histories from fertility surveys, 2000 and 2010 censuses, 2015 intercensal survey, vital statistics 1950-2015 and birth certificate

4. International migration

International migration from our country, primarily composed of the flow of compatriots to the United States, is a phenomenon of growing importance, not only from a statistical perspective, but also from a political, social, cultural, and human rights standpoint. The various facets of this phenomenon have been the subject of debate, but perhaps the most discussed has been the sheer volume of migration from Mexico to its northern neighbor.

The discussion dates back more than 25 years, when the first attempts to quantify the number of Mexicans in the United States—primarily undocumented immigrants—began to gain attention. The range of estimates varied by several million and depended largely on the algorithms and sources used (Tuirán, 1984, 1993). Following the work of Warren and Passell (1987), the methodology for estimating the documented and undocumented foreign population in the United States has become *more standardized*, explicitly incorporating migrant mortality and return migration to countries of origin into the estimation procedures. More precise algorithms consider various forms of entry and legalization of stay in the United States, and even establish different possible ranges of omission between documented and undocumented migrants (Bean *et al.*, 2001). Changes in the way habitual residence is defined, in the sources commonly used to make measurements, have led to questioning the possible over-enumeration of foreigners (Corona and Tuirán, 2006), when even at the end of the last century the concern was about underestimation.

The international migration estimates presented here are based on the Mexican population censuses from 1960 to 2010 and the United States population censuses from 1950 to 2000, demographic household surveys conducted in Mexico over the past twenty-five years, and the American Community Survey (**ACS**) from the United States over several years. Immigration flows and some emigration flows are derived from Mexican sources, while the remaining emigration flows are derived from U.S. figures. To make the most of the available information and produce more accurate estimates, four types of flows are considered:

1. Mexicans who move to the United States;
2. People not born in Mexico who leave our country to settle in our northern neighbor;
3. People born in Mexico who leave our country to settle in another country;
4. Immigrants from any country (returning nationals and foreigners).

Based on the most recent data, a reconstruction of migration flows from 1950 to 2015 is carried out. The estimates assume that the risk of death is the same for the entire population, regardless of country of birth or residence; the single mortality pattern corresponds to the national one estimated in Chapter 2.1 ¹ Immigrant figures are obtained directly from Mexican sources, information that is considered reliable; emigrant figures are based on the flow of Mexicans to the United States, and from this, estimates are made of foreigners migrating to the United States and overall emigration to other ² countries.

4.1 Mexican emigration to the United States 1950-2015

Our goal is to estimate consistent volumes of Mexican emigration to the neighboring country between 1950 and 2015. Our data sources are the United States censuses from 1950 to 2000 and the American Community Survey (**ACS**) from 2000 to 2015, which replaced the long - *form questionnaire*. from previous censuses, an instrument where international migration was captured up to the 2000 count. ^{3 4}

The US censuses from 1970 to 2000 recorded immigration by year of arrival. The **ACS**, in addition to the year of arrival for foreigners (born outside the United States), records the year of residence (county, state, or country) one year prior for the entire population, that is, regardless of place of birth. ⁴

Table 4.1 contains data from the 1970 to 2000 censuses, categorized by the period of Mexican arrival in the United States. As time passes, the survivors from earlier arrival years are a select few, not only because they have survived death, but—above all—because they have continued to reside in the United States since their last arrival. Thus, the number of those who reported in 1980 having last arrived in 1970 should be lower than the number counted in 1970. However, the opposite is true, as is also the case when comparing those who arrived before 1990 in the 2000 census with those counted ten years earlier. It is therefore necessary to temporarily harmonize the migration of Mexicans to the northern neighbor, in order to have the most accurate estimates of international emigration for the reconciliation exercise in chapter 5. Later we will see that the chronological series of the five years prior to 2000 , on the other hand, is consistent with the annual series of the **ACS** surveys from 2001 to 2015.

For the period 2000 to 2015 we used the information collected in the American Community

¹ The reason for making this assumption is the scarcity of information on that mortality differential.

² Several of the data used in this chapter come from published and unpublished tabulations of the United States censuses of 1970, 1980 and 1990 that were kindly given to me by Manuel García y Griego, Jeffrey Passel and Eduardo Arriaga, respectively, some years ago.

³ López and Gaspar (2011) offer a comprehensive discussion of the data sources for quantifying the migration of Mexicans to the United States; several of the considerations made in this chapter come from the original ideas of those authors.

⁴ We consider as a *foreigner* any person who lives in a country other than the one of their birth, regardless of their immigration status or nationality.

Census and period	Total	Men	Women
1970 Census	759 771	367,945	391 826
1980 Census			
Total 1970-1980	2199221		1 040456
Before 1970	1270246	1,158,765,695,	574679
	928 975	567,463,198	465 777
1990 Census			
Total 1980-1990	4 298 014 2	2 369 514	1 928 500
Before 1980	145 167 2 152	1233 258 1	911909 1
	847	136256	016 591
2000 Census			
Total 1990-2000	9 325 452 4	5 166 943 2	4 158 509
Before 1990	545 240 4 780	538 899 2	2 006 341
	212	628 044	2 152 168

Source: United States Population Censuses 1970, 1980, 1990 and 2000. Special tabulations (see footnote 2 in

Survey (ACS). Several years ago, information from the March supplement of the Current Population Survey (CPS) was used because it was the only source on migration for the intercensal period. Once the expanded census questionnaire was distributed annually starting in 2001, several authors have preferred the ACS due to its larger sample size. Indeed, at the beginning of the ACS, the number of Mexicans in the sample was 5,579 in the CPS and 24,696 in the ACS in 2001, whose expanded sample size was equivalent to 8,494,016 and 9,403,069 people, respectively, that is, 10.7% more in the ACS; 7,764 and 26,785 sample size in 2004, and 10,739,692 and 10,404,919 weighted, respectively, 3.1% less in the ACS; and for the 2015 survey, a sample of 4,004 in CPS and 93,030 in ACS, and expanded figures of 12,273,493 and 11,906,325, respectively, with 3.0% less in ACS.

It is undeniable that, for the same population and appropriate designs, a larger sample size yields more accurate results than a smaller one. The evidence in the previous paragraph is compelling: the ACS sample was 4.4 times that of the CPS in 2001, 3.4 times in 2004, and up to 23.2 times in 2015. On the other hand, the only significant difference is in 2001, when the expanded ACS figure was 10.7% higher; however, the number of Mexicans in the 2001 ACS (9,403,069) is more consistent with the 2000 census (9,325,452) than the weighted CPS figure for 2001 (8,494,016). It was along these lines of reasoning that we retained the ACS.

We have annual data for the first decade of this century, as the ACS is conducted annually. Table 4.2 presents the arrival and survey data collection flows by year. ⁵ It is

⁵ We omitted the 2000 ACS survey because it was a smaller test than the surveys.

They better quantify Mexicans by year of arrival. If we look at it row by row, we notice some consistency among the figures over the years. One alternative is to take the average of the observations; however, we discarded this because it would imply introducing probabilities of return and survival, as in the retrospective analysis we present below for the period 1950-2000. ^{*6}

Another option is to use migrants registered in the current year; however, since the survey is conducted throughout the year, the number of those who arrived in the year of the survey is only a fraction of the total for that particular year, because the survey does not capture those who arrived—during the year—after the interview. This is illustrated in Figure 4.1, where the dot represents an interview in March and a migrant who arrived in October; however, we do not know what fraction of the square corresponds to the upper triangle. Information is available on the monthly distribution of arrivals to the United States; however, this data does not allow us to distinguish between temporary and permanent migration, and we are only interested in the latter. Thus, we chose to attribute to the year of interest the migrants registered the following year: for example, 85,470 women for 2014 who were enumerated in 2015, as can be seen in the penultimate row of the corresponding panel in Table 4.2. Since we do not yet have the ACS survey for 2016, for the amount of 2015 we assumed the same proportion as for 2014, that is, for men $101,349 = 71,159 \times (103,067/72,365)$ and for women $90,969 = 49,544 \times (85,470/46,549)$.

Our goal is to reconcile the national demographic data annually, which requires disaggregating the five-year figures in Table 4.1 year by year. To do this, we use the results of the 2000 census. We use this data source because of its large sample size (one-sixth of the households where the long questionnaire was administered), which represents the largest historical volume of Mexicans interviewed in the United States censuses up to 2000; but above all, because it is the only available database that displays the arrival period by year, rather than by five-year and ten-year periods as in the censuses from 1970 to 1990.

Before estimating annual figures, we must harmonize census data from 1970 to 2000; that is, reconcile the population listed in the censuses from 1970 to 1990 with residents who arrived ten years later and declared having arrived a decade or more earlier. To do this, we combined census data from Mexico and the United States, the former to incorporate those who had returned to Mexico.

4.1.1 Reconstruction of Mexican emigration to the United States 1950-2000

Our goal is to estimate consistent volumes of Mexican emigration to the neighboring country between 1950 and 2000. We will illustrate this with the example of men from the 1990s-2000s, as shown in Table 4.3. The figures for Mexicans in the United States were taken directly from the 2000 census. We assume that 90 years is a sufficiently high

subsequent procedures. For the 2000 census, the expanded questionnaire was used, whose sample size is approximately equivalent to the total number of households visited during the entire decade 2001-

⁶ It is worth clarifying that the use of formulas (4.8), (4.9) and (4.10) for the 2000 census and earlier is due to the fact that we do not have migrants for each year, but only survivors at the time of the

arriv al	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Men														
2000	322	286	357	319	361	395	413	398	355	430	377,6	368	375	390	385
2001	454	426	482	477	505	458	496	530	776	676	89	641	267	074	023
2002	146,574	258,7	222	260	263	291	249	239,3	246	215,4	266	220	242	238	225
2003		97	053	751	842	876	285	58	112	95	404	318	214	043	136
2004		113,5	240	271	266,9	248	271	233	210	206	190	246	197,	197,2	193,
2005		38	575	627	57	192	521	451	817	132	230	400	326	76	047
2006			126,9	258	304	259	257,	251	217,9	189	186,4	175,7	232	177,7	177,
2007			83	537	345	334	654	835	14	229	12	44	151	65	740
2008				173,5	291,9	285	268,	243	248	219	200	196	175,	236	202
2009				60	93	072	897	354	250	243	073	217	868	122	376
2010					171,7	285,8	277,	245	223	266	228	206	210	187,5	240
2011					94	97	726	284	676	811	531	146	085	85	741
2012						140,9	231	216,6	205	181,5	191	168,0	166,	163,7	147,
2013							117	184,0	183,7	180,4	151,7	137,7	131	17	774
2014							182	82	86	82	23	32	632	77	188
2015							Survey	100	146,8	158	130,7	114,4	128,	111,7	114
								641	86	129	21	97	468	15	040
									68,959	11826	118	101,9	89	90	86
									1	067	49	020	182	551	
									73	96,92	97	87,5	95	98	
									815	5	553	45	858	044	
										67	74,61	77	79,81	67	
										201	2	61,17	020	3	161
												6	098	834	77
													58	81,36	85,3
													117	9	80
														72,36	103
														5	067

Table 4.2. Mexicans residing in the United States by year of arrival and ACS survey, 2001-2015

INTERNATIONAL MIGRATION

arriv al	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
							Wom en								
2000	232	246	273	256,6	304	319	330	313	293,6	373	335	312	321	339,	321
2001	310	227	180	70	603	803	786	306	97	613	019	464	466	620	921
2002	111	18751	185,7	209	215,7	231,7	199,	186,5	226	203	253	209,3	238	218	229
2003	512	3	38	157	44	49	357	15	534	232	228	62	411	909	305
2004		80	166,2	183,8	210	189,6	208	193,5	178,6	201	184	229	187	180	195,
2005		610	90	69	488	76	198	29	38	139	107	194	142	227	988
2006			89	161,8	201	206,3	190,	200	192,4	165,5	183,0	172,4	208	181,	163,
2007			165	13	329	99	725	512	50	92	85	69	217	893	716
2008				99	185,4	159,5	172,	190,5	198,4	185,5	183,7	179,9	161	214	171,
2009				191	63	54	000	48	26	58	09	90	153	268	560
2010						157,4	166,	170,7	175,6	214	192,7	180,6	199	182,	203
2011					86 851	96	532	27	19	445	71	77	147	741	131
2012						80,92	138,	126,6	139	151,3	147,8	138	138	146	134
2013						613	613	86	163	80	14	126	040	111	705
2014						66	66	102	115	137,3	115	113,6	128,4	125,	118,
2015						261	261	350	276	54	442	57	68	648	560
		Year of				54,43	91	149	91	105,7	105,7	103	101	102	109,
						8	774	166	774	166	80	671	137	116	615
							42,92	84	42,92	84	83,98	81	73,94	81	87
								309	6	309	8	541	5	178	844
								42,04		42,04	79,09	70,37	69,86	71,0	88
								4		4	2	8	6	87	847
											44,09	65	66 006	74	61
											6	091	006	703	522
												38,29	73	72,7	67,8
												9	849	74	82
													36	62	76,5
													203	287	22
														46,5	85
														40	170

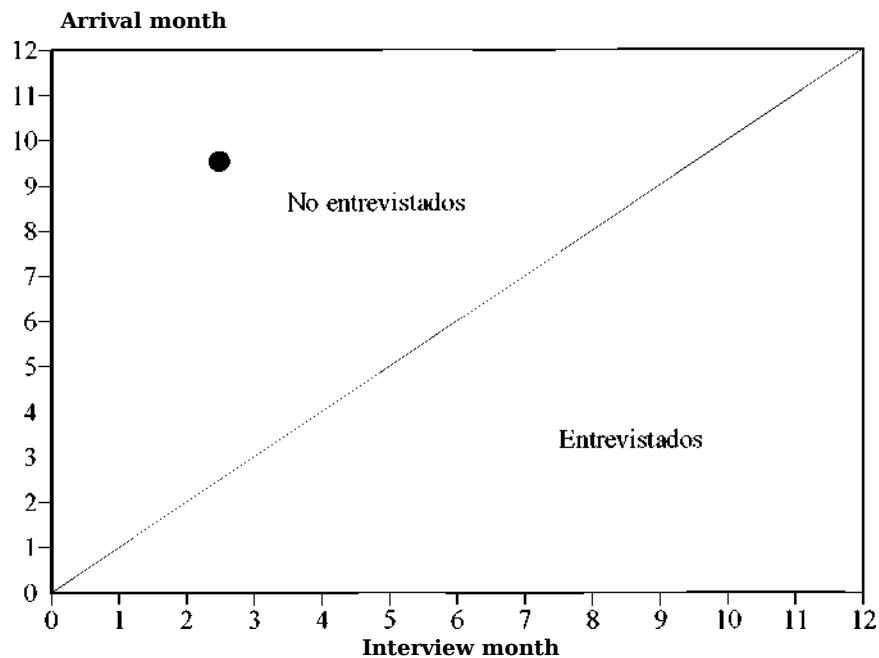
Table 2.3.
(Continued)

2015

49 544

Source: American Community Survey from 2000 to 2015, microdata databases downloaded from the US Bureau of the Census website .

Figure 4.1. Illustration of the collection of migrants who arrived in the same year as the American Community Survey



so that a significant number of people migrate; thus, we assume that all migration occurs before reaching the ninetieth anniversary.

From the 2000 census microdata base, we classified the population by five-year age groups, sex, country of birth (Mexico or other), and country of residence in 1995 (Mexico, other, and unspecified). For each age, sex, and country of birth, the unspecified 1995 residence category was prorated. For each age and sex separately, the combined distribution of country of birth and 1995 residence was overlaid on the mid-2000 population estimate in section 2.2.2. The corresponding figures for those born in Mexico and living in the United States in 1995, which we call **returns**, are reproduced in Table 4.3.

The biregional model consists of an extension to Demography of the stochastic Markov chain model (Rogers 1968, 1975, 1995). Let $P_i, x(t)$ denote the number of people aged x to $x + 4$ residing in region i at time t , and let $t(t + 5)$ denote the **number of people** present **in i at the beginning of the five - year period and in j at the end**, assuming no mortality (i.e., survivors at the time of the census interview), aged x to $x + 4$ at time $t + 5$; let i, j be 1 for Mexico and 2 for the United States. From a prospective perspective, the total in i at the beginning of the five-year period is:

$$bP_{i,x}(t) = 50\sum_{j=1}^2 E(U_{j,t+5}) + \tilde{n}O_{i,j,2,x}(t,t+5) \quad i = 1,2 \quad (4-1)$$

and, from a retrospective perspective:

Age in 2000	Person nel in 1990 (1)	Probabili ty survive (2)	Residents in 1990 (3)	1990-1995		Resid ents in 1995	Probabilit y of emigratin g	1995-2000		Resident s in 2000 (10)	Original s 1990- 1995
				Migrant s (4)	Immigra nts (5)			Migrants (8)	Immigra nts (9)		
Residents in Mexico											
0-4			5 788 072	0	0	5 788 072	0.0178			5,684,962	
5-9			5 948 809	53 862	0	5,894,947	0.0212	103 110	6045	5,775,678	0.00000
10-14			5,657,174	105,946	4142	5,555,370	0.0168	93 595	6833	5,468,608	0.0007
15-19			5 266 193	99 593	4463	5 171 063	0.0463	239,699	6013	4,937,377	0.0008
						4,773,250	0.0827			4,397,579	0.0009
20-24			4,969,731	200 850	4,369	4,770	0.0600	394,936	19,265	3,964,459	0.0033
25-29			4,441,797	272 058	14 147	4,183,880	0.0376	251 163	31,731	3,483,684	0.0058
30-34			3 698 401	128,549	21,140	3,590,997	0.0275	135 276	27,966	3,043,923	0.0058
35-39			3,163,826	70 502	18,065	3 111 389	0.0192	85 830	18,364	2,546,113	0.0044
40-44			2 612 802	39,912	11,565	2,584,455	0.0150	49,704	11,367	2,025,738	0.0034
45-49			2 065 010	22,739	7 134	2,049,405	0.0113	30,751	7079	1,614,473	0.0027
50-54			1,637,454	13,562	4 515	1,628,405	0.0088	18,542	4 608	1,292,526	0.0023
55-59			1,306,743	9013	3072	1 300 802	0.0075	11,509	3 233	1,035,576	0.0020
60-64			1,043,978	5 183	2150	1,040,945	0.0057	7897	2,527	803 627	0.0020
65-59			808 028	3403	1,648	806 273	0.0061	4,665	2019	585 214	0.0022
70-74			588 905	2333	1323	587 895	0.0051	3610	929	395 491	0.0013
75-79			398 083	1,569	533	397,047	0.0037	2045	489		0.0010
80-84			247 009	911	263	246 361	0.0039	929	225	245 657	0.0007
85-89			145 222	507	112	144,827	0.0000	574	90	144 343	0.0005
90-94			68 477	186	36	68 327		0	0	68 327	0.0000
95-99			22 021	0	0	22 021	0.0000	0	0	22 021	0.0000
100-104			3 532	0	0	3 532	0.0000	0	0	3 532	0.0000
105-109			228	0	0	228	0.0000	0	0	228	0.0000

0-4			0	0	0	0	0.00000	0	103	103	0
5-9			0	0	53	53	0.11223	6045	125,3	173	47817
10-14	50 701	0.99211	50 301	4142	105,9	152	0.04492	6833	14	238	101
15-19	100,72	0.99355	100 072	4463	99	195	0.03080	6013	239,6	428	96 525
	2				593	202			99	888	
20-24	146,66				200	341			394,9	717	189,51
	2	0.98852	144,978	4,369	850	459	0.05642	19,265	36	130	8
25-29	323	0.98138	317333	14	272	575	0.05416	31,731	251	794	257
30-34	254	0.97509	515 774	21,14	128,5	623	0.04488	27,966	135	676	122,78
35-39	552	0.96994	490,996	18,06	40	193	0.03379	18,364	75	610	68 120
	211				502	433			830	899	
	399				39,91	413			49,70	451	
40-44	140	0.96393	384 742	5	2	089	0.02752	11,367	4	426	38,814
45-49	290,93	0.95451	277,702	194	2,778	2,778	0.02114	10,779	30,79	216,9	22,190
	198	0.93933	186,748	4 515	13,56	195,7	0.02353	4 608	18,54	209,7	13 243
50-54	133	0.91601	122 110	3072	9013	128	0.02525	3 233	11,50	136,3	8,785
55-59	306					85			9	27	
						90					
60-64	93 249	0.88178	82 225	2150	5 183	258	0.02964	2,527	7897	628	5029
65-59	68 683	0.83333	57 236	1,648	3403	58,99	0.03423	2019	4,665	61,63	3287
						1				7	
70-74	50,837	0.76710	38,997	1323	2333	40007	0.02322	929	3610	42,68	2279
75-79	39,888	0.68013	27,129	533	1,569	28,16	0.01736	489	2045	29,72	1,542
						5				1	
80-84	25,918	0.57185	14,821	263	911	15,46	0.01455	225	929	173	898
						9					
85-89	18,949	0.44568	8445	112	507	8840	0.01018	90	574	9324	502
90-94	11,504	0.30738	3536	36	186	3,686	0.01707	0	0	3,686	183
95-99	7,493	0.17162	1 286	0	0	1 286	0.01832	0	0	1 286	0
100-104	2023	0.06721	136	0	0	136	0.01449	0	0	136	0
105-109+	614	0.01466	9	0	0	9	0.00000	0	0	9	0

Table 4.16.
(Concludes)

Residents in the United States

IN
TE
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R
A
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O
N

* The population aged 100 years and over in 2000 was divided into two five-year age groups, with the internal age structure of 100 years and over for Mexico (top panel). Sources: Estimates based on the 2000 Mexican and U.S. population censuses and mortality data from Chapter 2.

$${}_5P_{j,x}(t+5) = {}_5O_{ij,x}(t, t+5) + {}_5b_{02j,x}(t, t+5) \quad j=1,2 \quad (4-2)$$

Let us consider Mexicans residing in Mexico during the extreme years of the five-year period 1995-2000. From (4.1) we have that:

$$5^{(1995)} = {}_6O_{1M}(1995, 2000) + 56^{(1995, 2000)} \quad (4.3)$$

and by (4.2):

$$5A_{(2000)} = {}_6O_{1M}(1995, 2000) + 562^{(1995, 2000)}$$

Therefore, solving for:

$$5CV^{(1995, 2000)} = 5A^{(2000)} - {}_56_{21}$$

$^{(1995, 2000)}$ and substituting in (4.3)

$$5A^{(1995)} = 5A^{(2000)} - {}_66_{2,i}^{(1995, 2000)} + 561_{,2}^{(1995, 2000)} \quad (4.4)$$

For Mexicans residing in the United States, there is an analogous equation:

$$5^{(1995)} = {}_5A^{(2000)} - 561_{,2}^{(1995, 2000)} + {}_5d_{2,i}^{(1995, 2000)} \quad (4.5)$$

where ${}_{561,2}^{(1995, 2000)}$ is the number of Mexicans who returned to Mexico during the 1995-2000 period.

$$\text{and } {}_50_{2,i}(1995, 2000) = 19,265$$

then, evaluating (4.4):

$$5A_{is}(1995) = 4,397,579 + 394,936 - 19,265 =$$

4,773,250 and by (4.5) we have those who reside in the United States

$$5^{2,15}(1995) = 717,130 + 19,265 - 394,936 = 341,459$$

Both figures can be checked in column (6) of table 4.3.

Let ${}_5S_{(S),j,ir}(f, f+5)$ denote the proportion of residents in i at time f , present 5 years later in region j (equal to or different from i); its value is given by:

$${}_5S_{(S),j,ir}(f, f+5) = \frac{{}_5O_{ij,x}(f, f+5)}{{}_5I_{f:(Yo)}} \quad i, j=1,2 \quad (4.6)$$

Thus, for example, for the same 20-24 age group in 2000, the proportion of those returning to Mexico is:

$${}_5S_{2,i,i}(1995, 2000) = \frac{{}_50_{2,i}(1995, 2000)}{{}_5P_{2,15}(f)} = \frac{19,265}{341,459} = 0.05642$$

figure that appears in column (7) in the lower panel of table 4.3; and of those who remain in the United States:

$$5^{2,2,15}(1995,2) = \frac{502,215 (1995, 2000)}{hP2,1b(t)} = \frac{322,194}{4} = 0.94358$$

000) because when solving in

$$5^{0,2,2,15}(1995,2000) = 5^{P,2,2,15}(2000) - 5^{O,2,2,15}(1995, 2000) = 717,130 - 394,936 =$$

322,194 It can be seen that the two proportions add up to one:

$$5^{2,1,15}(1995, 2000) + 5^{2,2,15}(1995, 2000) = 0.05642 + 0.94358 = 1$$

This is because, under our biregional scheme, a Mexican in the United States only has two options: stay there or return to Mexico. Indeed, if we divide both sides of (4.1) by $5^{P,2,2,15}(t)$:

$$1 = \frac{5^{0,2,2,15}(t+5) + 5^{P,2,2,15}(t+5)}{5^{P,2,2,15}(t)} = \frac{5^{0,2,2,15}(t+5) + 5^{P,2,2,15}(t+5)}{5^{P,2,2,15}(t)} \quad (4.7)$$

How can we estimate the number of migrants in the first half of the decade? Those who migrated from Mexico to the United States would seemingly be the men in column (3) of Table 4.3. We say *seemingly* because, in order to have been counted in the 2000 census in the neighboring country, in addition to surviving the mortality rate—which we are momentarily setting aside—they also had to avoid returning to Mexico. Otherwise, they would have been part of the return migration during the second five-year period and would not have been counted in the United States. Let's denote by $5^{0,2,1,15}(1990,1995)$ the migrants from the first five-year period who did not return to Mexico during the second five-year period, where the symbol indicates that they avoided migration. If we assume that the probability of returning (migrating from Mexico to the United States) does not depend on the previous arrival period, the *actual number* of

$$5^{0,2,1,15}(1990,1995) = 5^{0,2,1,15}(1990,1995) \cdot 5^{2,2,15}(1995, 2000)$$

and clearing:

$$5^{0,2,1,15}(1990,1995) = \frac{5^{0,2,1,15}(1990,1995)}{5^{2,2,15}(1995, 2000)} \cdot 5^{2,2,15}(1995, 2000)$$

For our example of males aged 20²⁴ in 2000, as $5^{0,2,1,15}(1990,1995) = 189,518$ from Table 4.3 and $5^{2,2,15}(1995, 2000) = 0.94358$, then:

$$5^{0,2,1,15}(1990,1995) = \frac{189,518}{0.94358} = 200,850$$

as can be seen in the corresponding row of column (5) of table 4.3 for residents in the United States, and in column (4) for those living in Mexico.

Return migration data for the period 1990-1995, however, cannot be obtained using the same procedure, since the 2000 Mexican population census did not capture any migration prior to 1995. From the 1990 census, we extracted the proportion of returns for the preceding five-year period (residents in the United States in 1995) and assumed that the proportion, for each age and sex group separately, varied linearly with respect to time. Thus, the proportion for 1990-1995 is the arithmetic mean of the proportions for 1985-1990 and 1995-2000. Since return migration data for the first half of the 1980s cannot be obtained from the 1990 census either, we obtained the proportion for that five-year period as the arithmetic mean of the proportions for 1975-1980 (1980 census) and 1985-1990. The five-year proportions for the period 1975-2000 are presented in Table 4.4. For the other five-year periods, it is not necessary to calculate them because the 1960, 1970, and 1980 censuses asked about the years of residence in the place where the person was counted, so all arrival periods are available. Furthermore, the five-year frequency of the 2000 and 2010 censuses, the 2005 count, and the 2015 Intercensal Survey allow us to directly derive the migrants for the three five-year periods of 2000-2015.

The proportions refer to the fraction of returns among Mexicans residing in Mexico at the end of a five-year period. Thus, for our example of men aged 20-24 in 2000, since they were aged 15-19 in 1995, we apply the proportion for that age range, that is:

$$502,115 (1990,1995) = 4,369 = 4,773,250 \times 0.00092$$

as can be seen in column (5) of table 4.3 for residents in Mexico and in column (4) for those living in the United States.

The population residing in 1990, who survived the mortality during the decade, is obtained by applying formulas (4.4) and (4.5) again. For the cohort in our example, the residents in the United States are:

$$5-P2,io(1990) = 341,459 + 4,369 - 200,850 = 144,978$$

which can be checked in column (3) of table 4.3.

We are only interested in evaluating the coverage of the Mexican population living in the United States captured in censuses prior to 2000, since the data on Mexicans living in our country and international immigrants are taken from the census results of Mexico. Let $5iS'_x(1990,2000)$ denote the probability of surviving during the decade for those who were in the five-year age group $a:aa;+4$ at the beginning of the period, which does not depend on the countries due to the mortality prevalence assumption we made at the beginning of this chapter. If $5/7,3,(1990)$ is the **true** resident population in i in 1990, then the mortality survivors will be:

$$5^{(1990)} = 5^{(1990)}5^{(1990,2000)}$$

and clearing

in the end	1975-1980	1980- 1985	1985- 1990	1990-1995	1995- 2000
Men					
0-4	0.000000	0.000000	0.000000	0.000000	0.000000
5-9	0.000262	0.00035 ₂	0.00044 ₄	0.000746	0.001047
10-14	0.000304	0.00039 ₀	0.00047 ₇	0.000863	0.001249
15-19	0.001150	0.00088 ₂	0.00061 ₃	0.000915	0.001218
20-24	0.004234	0.00330 ₈	0.00238 ₂	0.003381	0.004381
25-29	0.004982	0.00437 ₆	0.00377 ₀	0.005887	0.008004
30-34	0.004396	0.00399 ₆	0.00358 ₀	0.005806	0.008028
35-39	0.003734	0.00332 ₅	0.00291 ₇	0.004475	0.006033
40-44	0.003269	0.00288 ₃	0.00249 ₈	0.003481	0.004465
45-49	0.002930	0.00249 ₁	0.002051	0.002773	0.003494
50-54	0.002497	0.00218 ₂	0.00186 ₉	0.002362	0.002854
55-59	0.002128	0.00187 ₉	0.00162 ₉	0.002065	0.002501
60-64	0.001748	0.00169 ₈	0.00164 ₇	0.002044	0.002440
65-59	0.001661	0.00182 ₅	0.00198 ₀	0.002251	0.002512
70-74	0.001415	0.00125 ₇	0.00109 ₉	0.001343	0.001587
75-79	0.001367	0.00113 ₃	0.00089 ₉	0.001067	0.001236
80-84	0.001165	0.00090 ₀	0.00063 ₆	0.000775	0.000915
85-89	0.001112	0.00077 ₅	0.00043 ₈	0.000531	0.000623
Women					
0-4	0.000000	0.000000	0.000000	0.000000	0.000000
5-9	0.000253	0.00034 ₈	0.000443	0.000766	0.001089
10-14	0.000304	0.00040 ₀	0.00051 ₄	0.000918	0.001321
15-19	0.000777	0.00072 ₅	0.000673	0.000967	0.001260
20-24	0.001736	0.00144 ₈	0.00116 ₀	0.001689	0.002218
25-29	0.001931	0.00175 ₄	0.00157 ₇	0.002676	0.003774
30-34	0.001646	0.00162 ₂	0.00159 ₇	0.002598	0.003599
35-39	0.001098	0.00123 ₅	0.001371	0.001898	0.002424
40-44	0.000873	0.00096 ₉	0.00106 ₆	0.001372	0.001678
45-49	0.000793	0.00084 ₁	0.00088 ₀	0.001156	0.001424
50-54	0.000975	0.00091 ₃	0.000851	0.001121	0.001391
55-59	0.001111	0.00103 ₃	0.000956	0.001213	0.001469
60-64	0.001085	0.00107 ₆	0.001066	0.001271	0.001475
65-59	0.000970	0.00094 ₇	0.000924	0.001115	0.001307
70-74	0.000896	0.00085 ₂	0.000808	0.000914	0.001020
75-79	0.000851	0.00079 ₅	0.000739	0.000858	0.000976
80-84	0.000735	0.00065 ₃	0.000569	0.000673	0.000777
85-89	0.000734	0.00068 ₇	0.000641	0.000867	0.001093

Source: Estimated based on the Mexican population censuses of 1980, 1990 and 2000.

Age in 1990	Census				Retrospect			
	Total	1985-1990	1980-1984	Before 1980	Total	1985-1990	1980-1984	Before 1980
Total	2,369,514	730 893	502342	1 136256	2 997952	952389	652249	1393 314
0-4	52447	52447	0	0	50701	50701	0	0
5-9	78906	57289	21617	0	100,722	73128	27594	0
10-14	105,632	45,370	35,774	24488	146,662	62993	49669	34000
15-19	216 179	111938	39798	64443	323 354	167,433	59,529	96392
20-24	396386	204123	110749	81514	528 952	272,389	147788	108775
25-29	369,782	113,548	123 656	132,578	506 211	155 441	169278	181492
30-34	351 037	62738	87265	201034	399140	71335	99 223	228 582
35-39	238,715	32106	34772	171837	290,937	39130	42,379	209428
40-44	166,423	17940	18408	130075	198 809	21431	21990	155,388
45-49	116 022	12,557	12,178	91287	133 306	14428	13,992	104886
50-54	84 561	8159	7475	68927	93 249	8997	8 243	76 009
55-59	58,617	4981	4172	49464	68 683	5836	4888	57959
60-64	41241	3119	2 532	35,590	50,837	3845	3 121	43 871
65-69	34667	1976	1638	31053	39,888	2274	1885	35,729
70-74	20,350	1,174	1000	18,176	25,918	1495	1274	23,149
75-79	17 222	834	649	15,739	18,949	918	714	17317
80-84	11435	372	397	10,666	11504	381	407	10,716
85-89	7 215	222	241	6,752	7493	234	254	7005
90-94	2013	0	21	1992	2023	0	21	2002
95-99	543	0	0	543	520	0	0	520
100 Or more	98	0	0	98	94	0	0	94

Source: 1990 Population Census and Table 4.3.

5-fvc(1990)
5
^
(
1990
)

(4.8)

The survival probabilities are reproduced in column (2) of Table 4.3. Thus, the Mexican males residing in the United States in 1990, aged 10-14 years, are:

5-f2,io(1990)
5
P
2
,
i
o
(1990)
144,
5
Sio(1990,
779
146,662

population shown in the first column of table 4.3. It is noted that the sum over all ages amounts to 2,997,952, which is 26.5% higher than the total census of 2,369,514 (table 4.1).

Table 4.5 presents the Mexican men counted in the 1990 United States Census and our retrospective estimate. The distribution by census arrival period was overlaid on these latter figures for each five-year age group. For our example, in 1985-1990:

$$62,993 \quad 45,370 \times \frac{146,66}{2} \\ 105,62$$

and during 1980-1985:

$$49,669 \quad 35,774 \quad \frac{146,66}{2} \\ 105,62$$

and for before 1980:

$$34,000 = 146,662 - 62,993 - 49,669$$

Using the data from the right panel of Table 4.5 and the data from the 1990 Mexican census taken mid-year, and the proportions for 1980-1985 from the top panel of Table 4.4, we carried out the retrospective from 1990 to 1980, in the same way as was done in Table 4.3. The process was repeated until the retrospective from 1960 to 1950 was completed, and was replicated for women.

We have the estimate of Mexicans in the United States per five-year period of arrival, surviving at the time of the censuses from 1960 to 2000. To transform them into actual occurrences, it is necessary to add those who, having emigrated from Mexico to the northern neighbor, were prevented from being enumerated by death.

The emigrants from the first five years of the decade, besides not having returned to Mexico, must also have survived the second five-year period. Thus, the first step was to regress them by survival during the second half of the decade, for example, for 1990-1995, as in (4.9):⁷

$${}_5O_{21}^{\wedge}, (1990, 1995) \quad \frac{{}_5O_{21}^{\wedge}, (1990, 1995)}{({}_5O_{21}^{\wedge}, (1990, 1995))} *$$

where $\wedge^{\wedge}, 1, (1990, 1995)$ are the total emigrants from Mexico between 1990 and 1995, survivors in 1995 in the United States.

Let's consider two extreme cases: all deaths occur a few seconds after the start of the five-year period; and all occur a few seconds before the end. The total number of emigrants, for the period 1995-2000 for example, would be in both situations:

$$\frac{{}_5O_{21}^{\wedge}, (1995, 2000)}{({}_5O_{21}^{\wedge}, (1995, 2000))} \quad \text{and} \quad \frac{{}_5O_{21}^{\wedge}, (1995, 2000)}{({}_5O_{21}^{\wedge}, (1995, 2000))} *$$

An intermediate position is more reasonable. If we assume that migrations and deaths are evenly distributed over the five-year period, the **actual number** of emigrants corresponds to the arithmetic mean of the two extreme positions:

⁷ Remember that for migrants O the age is at the end of the five-year period and for the survival quotient S it is at the beginning.

Census and period	Total	Men	Women
1950-1955	149,597	82 211	67,386
1955-1960	234,795	117,607	117 188
1960-1965	318 245	170,996	147 249
1965-1970	415 328	222 885	192,443
1970-1975	815 085	454 352	360 733
1975-1980	1,041,547	597,977	443 570
1980-1985	1 172 002	689 428	482 574
1985-1990	1652 219	959 398	692 821
1990-1995	1,979,329	1,049,640	929 689
1995-2000	2,695,708	1,568,652	1,127,056

Sources: Estimates based on the population censuses of Mexico and the United States from 1960 to 2000 and mortality data from Chapter 2.

$$502,1 \wedge (1995, 2000) + 502,1 \wedge (1995, 2000) = 502,1 \wedge (1995, 2000) \quad (4.9)$$

and, for the first five-year period:

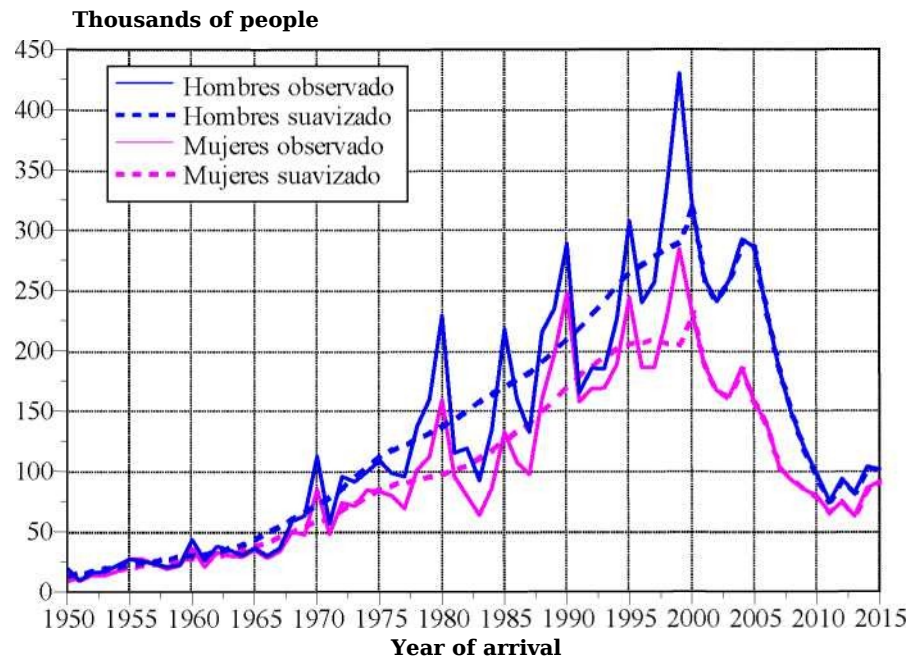
$$502,1 \wedge (1990, 1995) = 502,1 \wedge (1990, 1995) \quad 1 + 5 \wedge - 5(1990, 1995)$$

The totals for both sexes are reproduced in Table 4.6.

The breakdown by calendar year was done using the arrival year reported in the 2000 census. We used only that U.S. population count because the census sample data available for the 1950–2000 censuses only report five-year and ^{ten}-year arrival periods, not individual years. We are aware that, as time passes, the survivors from earlier arrival years are select, not only because they have survived death, but—above all—because they have continued to reside in the United States since their last arrival. However, since we will only use the arrival year captured in the 2000 census to disaggregate the five-year figures, it is appropriate to assume that the presumed selectivity should not be different among the five arrival cohorts of each of the five-year flows from 1950 to 2010. The annual series of Mexicans residing in the United States by year of arrival is reproduced in graph 4.1.

⁸ <https://usa.ipums.org/usa/sampdesc.shtml> .

Figure 4.1. Population born in Mexico residing in the United States by year of arrival and sex, 1950-2015



Source: United States Censuses 1970-2000 and ACS 2000-2015; adjusted 1950-1999.

The 2000 census data show a clear preference for the digit zero when reporting the year of arrival (lines labeled “observed” in Figure 4.1). To correct for this digital preference, we smoothed the trend from 1950 to 1999 using the robust *lowess procedure* in the STATA software package (2003), with a 30% window of observations from 1950 to 2015. The smoothing is shown in Figure 4.1. For each five-year period, the annual smoothing values were applied to the total estimated in Table 4.6; the results are shown in Table 4.7.

4.1.2 The breakdown by age

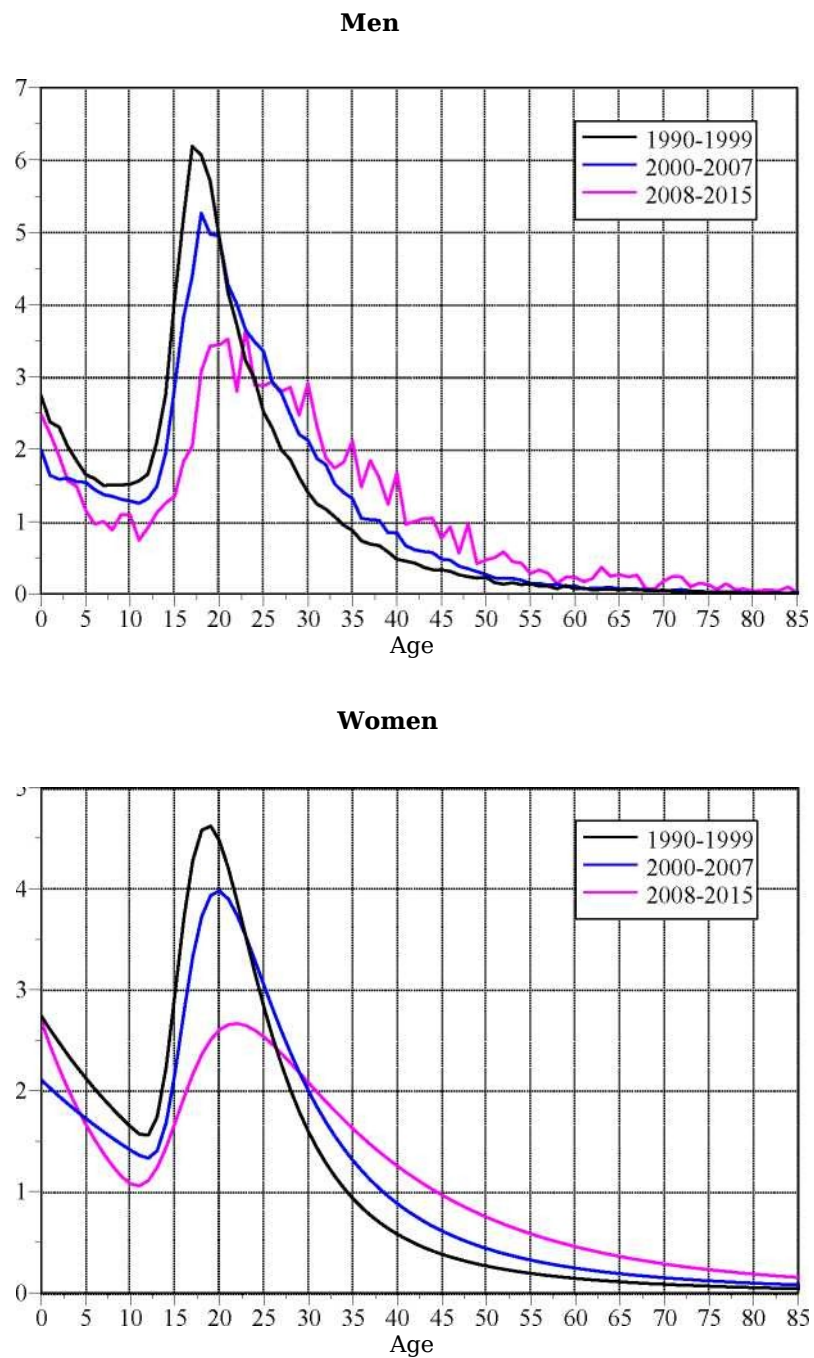
Once the migrants have been identified by sex, it is necessary to overlay them with an age structure. Age disaggregation is essential for carrying out the demographic reconciliation exercise in the following chapter. The age composition must be broken down by individual years to obtain annual populations for the reconciliation.

Figure 4.2 presents the age structures of Mexicans who arrived in the United States in the decade prior to the 2000 census and for two seven-year periods of the American Citizenship Survey (ACS). They are grouped within these longer time periods to create the smoothest possible age pattern, and correspond to the arithmetic mean of the age structures for each of

Year	Total	Men	Women	Year	Total	Men	Women	Year	Total	Men	Women
1950	23,778	13,584	10,194	1972	154,443	86,395	68,048	1994	455,827	254,324	201,503
1951	28,241	15,605	12,636	1973	168,478	94,835	73,646	1995	469,799	264,137	205,572
1952	32,168	17,311	14,849	1974	182,878	103,486	79,392	1996	479,042	271,792	207,250
1953	35,455	18,766	16,693	1975	195,719	111,247	84,501	1997	485,987	278,411	207,477
1954	38,581	20,242	18,339	1976	205,789	117,403	88,386	1998	491,373	284,549	206,824
		21,859			213				494		205
1955	41,755	21,859	19,896	1977	409	122,289	91,120	1999	477	289,431	046
1956	45,019	23,585	21,434	1978	220	127,024	93,325	2000	554	322,454	232
1957	48,247	25,298	22,949	1979	249	132,121	95,472	2001	772	258,797	210
		26,908			227,593				446		187,513
1958	51,317	26,908	24,410	1980	235	137,385	97,712	2002	406	240,575	166,293
1959	54,041	28,327	25,720	1981	227	143,204		2003	865	258,537	161,811
		29,565			243		100,680		420		185,463
		30,955			884				350		157,496
1960	56,431	30,955	26,866	1982	254	149,823	105,017	2004	477	291,993	157,496
1961	58,996	32,032	28,041	1983	840	157,249	111,047	2005	456	285,897	138,613
1962	62,401	33,843	29,499	1984	268	164,496	118,056	2006	443	231,883	102,350
1963	67,441	35,843	31,598	1985	282	170,839	125,288	2007	370,426	184,082	91,774
		39,640			296				286		84,309
1964	73,967	39,640	34,327	1986	127	176,467	132,537	2008	432	146,886	79,092
1965	81,626	44,877	37,554	1987	309	182,468	140,291	2009	238	118,261	65,091
1966	90,074	48,947	41,134	1988	322	190,061	149,205		660	96,925	73,849
1967	99,213	54,176	45,037	1989	358	199,148	159,037	2010	202	81,369	62,287
		59,852			358			2011	176		85,470
		65,922			366				139,703		90,969
1968	109,141	65,922	49,289	1990	185	208,686	168,790	2012	166,947	93,098	73,849
1969	119,722	72,266	53,796	1991	377,476	218,783	178,043	2013	143,656	81,369	62,287
		78,959			396,826			2014	188,527	103,067	90,969
1970	130,580	78,959	58,344	1992	416,963	230,111	186,852	2015	192,318	101,349	
1971	141,989	82,266	63,030	1993	437,392	242,434	194,958				

Source: United States Censuses from 1970 to 2000 and American Community Survey from 2000 to 2015; adjusted from 1950 to 1999.

Figure 4.2. Age structure of Mexicans residing in the United States for three arrival periods, 1990-2015



Source: Estimates based on the 2000 census and the ACS from 2001 to 2015.

Parameter	Men			1990-1999	Women	
	1990-1999	2000-2007	2008-2015		2000-2007	2008-2015
to	0.02358	0.01832	0.02479	0.02772	0.02123	0.02774
ai	0.04512	0.04095	0.10777	0.05111	0.04003	0.09756
a₂	0.09453	0.06876	0.05989	0.07908	0.05945	0.03996
a₂	0.17387	0.11115	0.06732	0.15214	0.11060	0.05245
A₂	0.52205	0.46913	0.26960	0.36924	0.36717	0.24684
M₂	15.4210	15.7501	17.1384	16.5338	16.8206	16.9586
C	0.00001	0.00002	-0.00033	0.00003	0.00002	0.00039

Source: Estimates based on the 2000 census and the ACS from 2001 to 2015.

the years included in the corresponding period. In the case of the ten years prior to the 2000 census, emigrants were placed at the age at the time of emigration.

In all three periods and both sexes, the classic age composition of international migration is evident : high concentration in young people and young adults, lower in children and adolescents —who presumably travel with their young and young adult parents— and almost none in late adulthood.

In order to avoid fluctuations in the age composition of the base population — especially in the most recent seven-year period—, we opted to smooth the age structure of the migrants for each of the three periods, using the parametric function of Rogers and Castro (1982):

$$h_x = \frac{O_i \exp \{-a_1 x\} + a_2 \exp \{-a_2 x^2\}}{1 + \exp \{-a_2 x^2\}} \sim \frac{1}{2} (1 + e^{-A_2 x^2})$$

The parameter values are shown in Table 4.8 and the associated age compositions in Figure 4.3

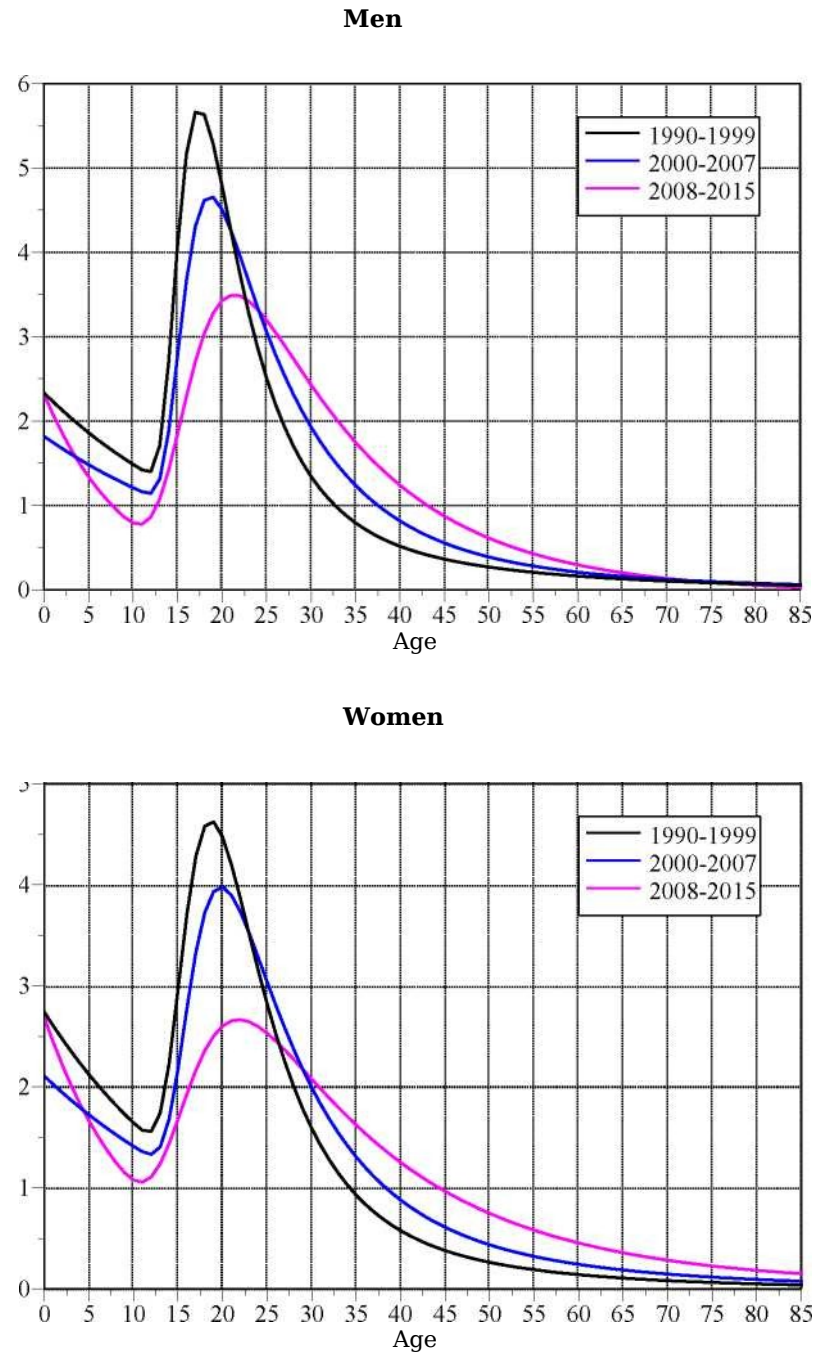
Based on William Brass's (1975) original idea for the age composition of the population via logistic transformation, the age structures of each year of the 1990-2015 period were adjusted, taking as standard function the one adjusted for the decade or seven-year period of belonging.

Let $H_x(t)$ be the cumulative proportion up to the exact age x of the total number of emigrants in year t , the logistic transformation is:

$$\text{And } x(t) = \frac{H_x(t)}{1 - H_x(t)} \quad (4.10)$$

sin* is the logito of the standard pattern (the age-adjusted composition of the decade or septennium) a sensitive linear relationship between the logits is expected:

Figure 4.3. Standard age structure of Mexicans residing in the United States for three arrival periods



Source: Estimates based on the parameters in Table 4.8.

Year of arrival	Men			Women		
	<i>to</i>	<i>p</i>	EMA	<i>to</i>	<i>P</i>	EMA
1990	0.36165	1.35505	24.1	0.10016	1.23806	17.6
1991	0.50051	1.25831	19.4	0.20269	1.22032	17.7
1992	0.44213	1.29236	20.5	0.06067	1.17271	14.2
1993	0.38794	1.36427	26.1	0.16214	1.18672	17.5
1994	0.30087	1.24573	19.3	0.02622	1.08619	11.8
1995	0.16400	1.26262	20.6	-0.06308	1.11363	14.7
1996	0.12380	1.28867	23.6	-0.09223	1.17166	21.1
1997	-0.02889	1.30506	20.0	-0.11164	1.11088	17.7
1998	0.09061	1.27439	30.6	-0.00562	1.00779	12.8
1999	-0.15120	1.31924	35.7	-0.05865	1.03955	18.3
2000	0.39842	1.38622	22.1	0.25374	1.31179	17.1
2001	0.36006	1.25264	22.1	0.23828	1.21718	16.2
2002	0.33658	1.23094	19.5	0.15994	1.20781	18.8
2003	0.28307	1.26689	20.5	0.14301	1.14517	14.0
2004	0.28841	1.33205	27.4	0.20305	1.19223	18.7
2005	0.16154	1.32282	23.8	0.11177	1.13836	12.9
2006	0.01537	1.20327	16.3	-0.02348	1.03894	11.3
2007	-0.07785	1.19356	20.6	-0.10819	0.99438	12.6
2008	0.20376	1.05610	17.7	0.12443	1.17837	18.0
2009	0.13498	1.08254	19.7	0.13189	1.12249	19.0
2010	-0.00784	0.93751	19.6	0.10508	1.10811	22.7
2011	0.13100	0.88845	27.8	0.18560	0.95753	25.2
2012	0.08942	0.92977	28.1	0.03048	0.92359	32.8
2013	0.14212	0.90827	41.6	0.35361	0.89012	46.0
2014	0.12969	0.93680	50.5	0.15623	0.99232	58.2
2015	-0.03989	0.92646	48.1	0.08629	0.83194	55.1

Source: Estimates based on the 2000 census, the 2001-2015 ACS parameters in Table 4.8.

$$Y_i(t) = a + bY_i \quad (4.11)$$

The parameters were obtained using robust regressions (STATA rreg command , **2003**) . Once the parameters *a* and *b* were obtained, the fitted values $Y_i(t)$ were obtained

$$H_x(t) = \frac{\exp \{bY_i(t)\}}{1 + \exp \{bY_i(t)\}} \quad (4.12)$$

and the final age structure broken down as follows:

$$hx(t) = H_x + i(t) - \tilde{n}_{x+i}(t) \quad (4.13)$$

Table 4.9 reproduces the parameters of the regression line.

As a goodness-of-fit test, we adopt the mean absolute error (MAE), which for a particular age structure is defined as:

$$EMA = \frac{\sum_{i=1}^{89} | \hat{M}_i - M_i |}{90} \times 100$$

EMA values associated with the adjustment are included in Table 4.9, using the percentage age structure. The worst fit (highest EMA) is for women in 2014. The upper panel of Figure 4.4 contrasts the age composition derived from the ACS with the adjusted composition for that case. The most marked discrepancy is observed in the first two years of life, which contribute 8.0% of the total EMA (58.2%), and from age 20 onward, with 37.5%. In contrast, the best fit, corresponding to women in 2006 (lower panel of Figure 4.4), shows a close relationship between the observed and smoothed values.

In all cases the probability of not rejecting the hypothesis that $\mu_3 = 0$ is less than 0.0001; and only in 6 (1997-1999, 2006, 2010, and 2015) among the 26 male observations, and in 7 (1990, 1992, 1994-1996, 1998, and 1999) of the female observations, did the probability of not rejecting the hypothesis that $\alpha = 0$ exceed 0.05. Among these 13 patterns, those with the greatest absolute value of α (let's say, the greatest deviation from zero) were the women of 1990 and the men of 1999. In the female case, the EMA would increase from 17.6%—under the original value of α —to 18.2% with $\alpha = 0$, and in the male case, it would increase from 35.7% to 40.4%; but among the adjustments—with *the* original α *already* = 0 —, the EMA would be 5.6% in women and 8.4% in men: a really small difference. In reality, it is parameter β that

4.2 Other international migrants

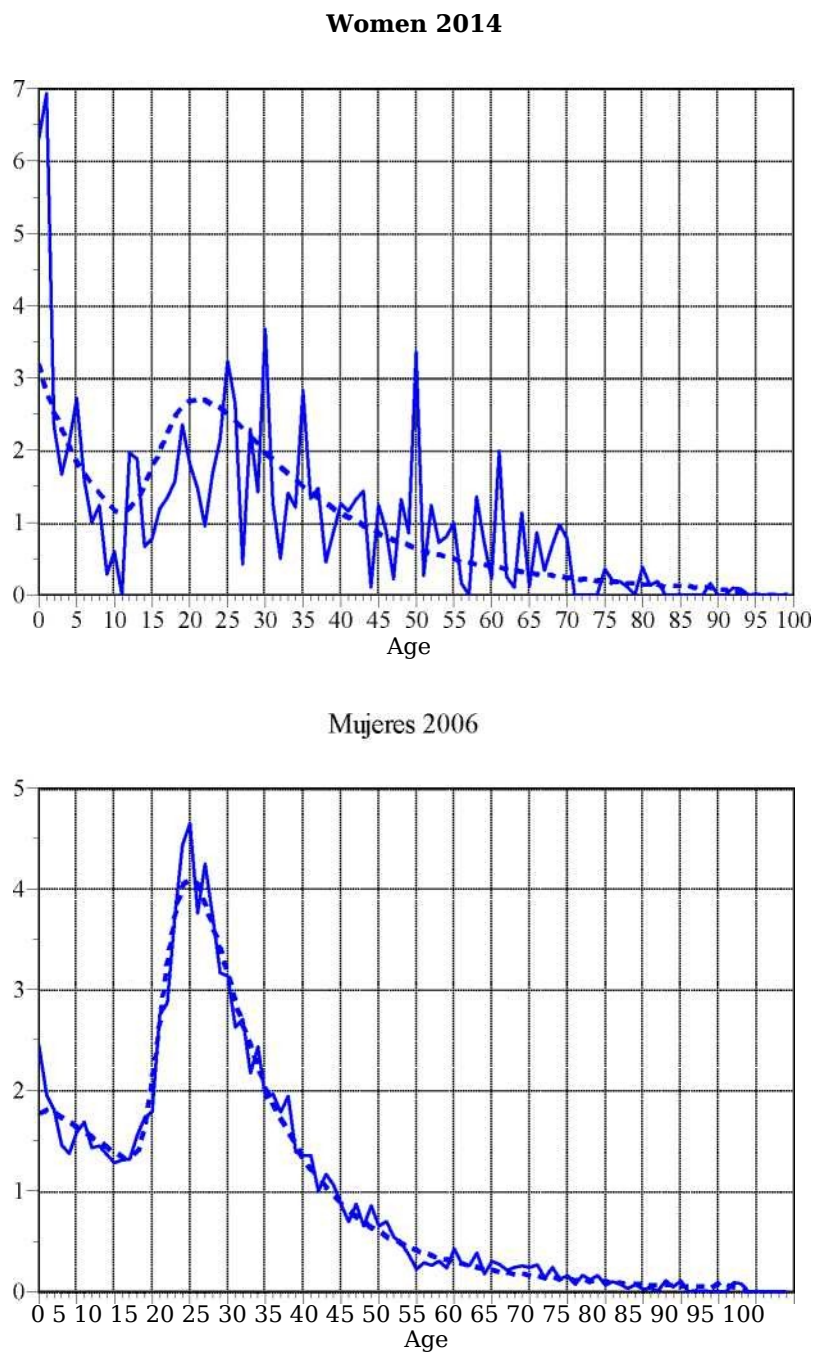
International emigration from Mexico is not only made up of Mexicans who move to the United States; it also includes foreigners who go to live in the United States and Mexicans and foreigners who change their residence to countries other than the northern neighbor.

The first of the aforementioned additional components, foreigners moving from Mexico to the United States, can be deduced from available data from the 1950, 1980, and 2000 U.S. population censuses and from information gathered by the ACS. The second component can be estimated from data from the 2000 and 2010 Mexican censuses. Let us first examine the additional emigration to the United States and then that to the rest of the world.

The emigration of foreigners from Mexico to the United States is obtained from the question about residence at a previous date (5 years for the 1980 and 2000 censuses and 1 year for the 1950 census and the ACS), since, in the North American data sources, the country of direct origin (presumably linked to the year of arrival) of those born

⁹ THE ITEMS in Table 4.9 must be divided by one hundred if the age composition is taken as a decimal instead of a percentage.

Figure 4.4. Observed and smoothed female age structure of Mexican emigrants in the United States for two selected years



Source: Estimates based on the 2000 census, the 2001-2015 ACS and the parameters in Table 4.8.

Period	Total	Men	Women
Born in Mexico			
1949-1950	11689	9961	1728
1975-1980	726 143	405 041	321 102
1995-2000	1740431	1037 925	702 506
2000-2004	1 768947	1086935	682012
2005-2009	1,143,563	736917	406646
2010-2014	663 883	399310	264573
Born in another country			
1949-1950	1313	1092	221
1975-1980	62,679	32,524	30155
1995-2000	221 133	136027	85 106
2000-2004	248494	136479	112015
2005-2009	257025	146 169	110 856
2010-2014	254068	131 050	123 018
Born in another / Born in Mexico			
1949-1950	0.11233	0.10963	0.12789
1975-1980	0.08632	0.08030	0.09391
1995-2000	0.12706	0.13106	0.12115
2000-2004	0.14048	0.12556	0.16424
2005-2009	0.22476	0.19835	0.27261
2010-2015	0.38270	0.32819	0.46497

Source: United States Censuses 1950, 1980 and 2000 and ACS 2001-2015.

Table 4.10 contains data on Mexican and foreign emigrants for the periods for which we were able to obtain information. The ratio of foreigners to Mexicans shows a decrease from 1949-1950 to 1975-1980 and an increase from 1975-1980 onward, perhaps reflecting the growing immigration to Mexico. After remaining in our country for some years and not finding their expectations met, they chose to continue their journey to our northern neighbor.

The addition of foreigners to the migratory flow to the United States was done in the following way. Let E^m be the Mexican emigrants, E^x the foreigners and $p = E^x / E^m$:

1. p proportions of 1949-1950 remained until 1970, considering that during most of that period the **Bracero Program was in effect** , which to some extent "opened" the border.
2. **proportion (p) for 1975-1980** was kept constant during the six years of the period, and that for 1995-1999 was kept constant throughout that five-year period. The proportions for 1971-1974 and 1981-1994 were estimated by linear interpolation with respect to time, based on those assigned to 1970, 1975, 1980, and 1995.

3. The proportions p for 2000–2004, 2005–2009, and 2010–2015 were assigned to the intermediate year, i.e., 2002, 2007, and 2012, respectively. The years between 2000 and 2001, 2003–2006, and 2008–2011 were obtained by linear interpolation with respect to time, based on the known extreme years.
4. Finally, the proportion p from 2010–2015 remained constant from 2013 to 2015.

The chosen proportions were superimposed on the previously obtained totals of Mexicans (Table 4.7). The estimate was made for each sex separately and is presented in Table 4.11.

The number of Mexican emigrants to countries other than the United States has not yet been included. We made the estimate indirectly because it is impossible to obtain immigration data for every country in the world, and population censuses are conducted at different intervals and do not always capture international migration.

In the five surveys (1992, 1997, 2006, 2009, and 2014) of the National Survey of Demographic Dynamics (ENADID) and the 2000 and 2010 population censuses (expanded questionnaire) in Mexico, modules were included to capture migration from our country to other nations. Since 2005, THE NATIONAL SURVEY OF OCCUPATION AND EMPLOYMENT (ENOE) has asked about the destination of those who left their homes. By knowing the destination country of these international migrants, we can distinguish between those going to the United States and those going to other countries, and, based on this distribution, estimate those who do not complete their migration in the United States.

Due to the considerably larger sample size, we selected data from the 2000 and 2010 censuses to make the estimate. It is important to clarify that, by proceeding in this way, we are implicitly assuming that the proportion of entire households that migrated abroad, or the fraction of household arrangements that dissolved with one or more of their former members having emigrated, is the same in both migration flows (to the United States and the rest of the world). This assumption is necessary because there is no respondent in the census, as the household is either not present or no longer exists. Clearly, if the fraction of these households relative to the total number of households differed depending on the migration flow, the breakdown by country of destination would be skewed.

According to the 2000 census, for every 10,000 men who moved to the United States, 1,078 emigrated to another country between 1995 and 2000, and for every 10,000 women, 1,331 did so. The corresponding proportions for the five-year period 2005–2010, as reported by the 2010 census, were 911 and 1,828, respectively. The proportions from the 2000 census were used for the period 1950–1999, and those from the 2010 census for the period 2000–2014; within both periods, they remained constant throughout the years.

While it is difficult to accept that the 1995–2000 proportion had prevailed since 1950, we require it to incorporate international migration into the mortality rate estimate in Chapter 2. Even if we used the 1987–1992 data (86 per ten thousand for men and 265 for women) collected in the 1992 ENADID survey, we would have to assume invariability during the previous 37 years (1950–1986). However, both these proportions

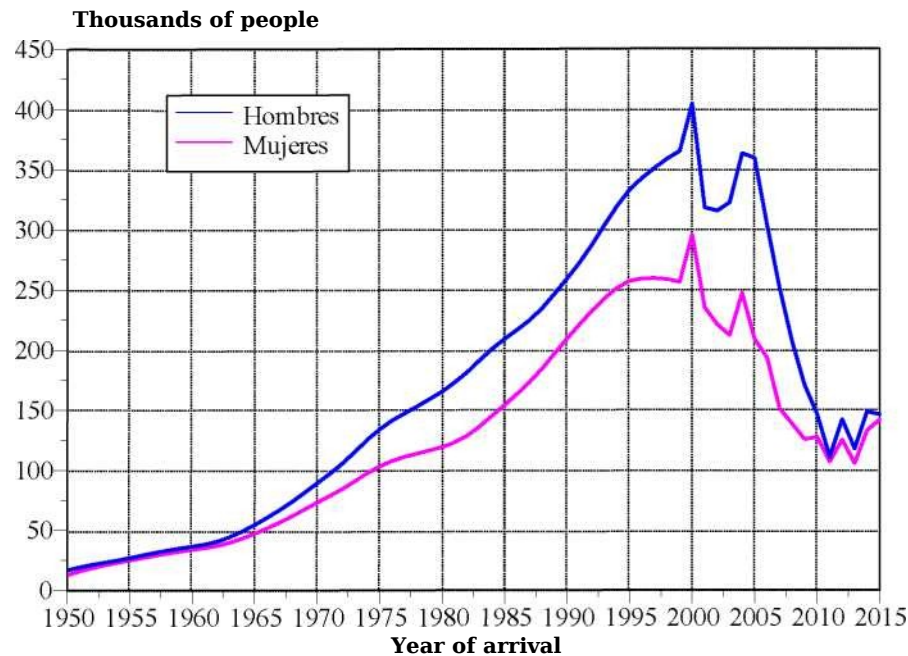
Year	Total	Men	Women	Year	Total	Men	Women	Year	Total	Men	Women
1950	26,571	15,073	11,498	1972	170,679	94 853	75,826	1994	512 342	286,794	225 548
1951	31,568	17,316	14,252	1973	185 126	103,563	81,563	1995	529 330	298,754	230 476
1952	35,966	19,218	16,748	1974	199,700	112 403	87,387	1996	539,740	307 412	232 358
1953	39,647	20,819	18,828	1975	212,617	120 180	92 437	1997	547 510	314 899	232 611
1954	43 145	22,461	20,684	1976	223 516	126 830	96 686	1998	553 721	321 841	231 880
1955	46,696	24,255	22,441	1977	231,786	132 109	99 677	1999	557 250	327 363	229,887
1956	50,346	26 171	24,175	1978	239 213	137 224	102 089	2000	628 008	362 813	265 195
1957	53,955	28 071	25,884	1979	247 168	142,730	104,438	2001	496 481	285 365	210 831
1958	57,389	29,857	27,532	1980	255 205	148,417	106,888	2002	481 163	283 095	198,068
1959	60 435	31,426	29009	1981	265 506	155 188	110318	2003	479 207	289 144	190 063
1960	63 108	32 806	30 302	1982	278 128	162,867	115 261	2004	547 565	325 885	221 680
1961	65,976	34,348	31,627	1983	293 552	171,472	122 080	2005	509 509	322 400	187 199
1962	69,781	36,509	33 272	1984	309 931	179,931	130,000	2006	445 542	272 158	173,384
1963	75,411	39,772	35,639	1985	325 639	187,448	138 191	2007	360 588	225 328	135 260
1964	82 703	43,986	38717	1986	340 648	194 220	146,428	2008	309 308	185,353	123 955
1965	91 261	48904	42,357	1987	356 691	201 442	155 249	2009	265 292	152 861	112431
1966	100 700	54 305	46,395	1988	375 852	210 468	165,384	2010	245 104	131 098	114 006
1967	110912	60 115	50,797	1989	397,775	221 204	176,571	2011	194,952	99 292	95 660
1968	122 006	66 413	55,593	1990	420 211	232 505	187,706	2012	239,407	127,324	112 083
1969	133,829	73 153	60,676	1991	442 814	244 495	198,319	2013	199,943	105 471	94 472
1970	145,961	80 155	65 806	1992	466 404	257,933	208 471	2014	252 429	133 193	119 235
1971	157,815	87 152	70,663	1993	490 434	272,566	217,868	2015	257,880	130,973	126,907

Source: Calculated based on tables 4.7 and 4.10.

Year	Total	Men	Women	Year	Total	Men	Women	Year	Total	Men	Women
1950	29,605	16,794	12811	1972	190169	105,684	84 485	1994	570846	319 543	251 303
1951	35 172	19,292	15,879	1973	206266	115,389	90 877	1995	589,662	332 868	256,794
1952	40,072	21,412	18,660	1974	222604	125 238	97 366	1996	601406	342 515	258 891
1953	44 174	23,192	20,978	1975	236604	133 903	102,992	1997	610406	350 857	259 173
1954	48 072	25,026	23,046	1976	249895	141,313	107,726	1998	616030	358 592	258 358
		27,025			039258				950620		
1955	52,029	29,150	25 004	1977	253266,6	147 194	111 059	1999	882699	364,744	256 138
1956	56,095	31,276	26,936	1978	275,392	152,894	113,746	2000	388552	404 051	295,337
1957	60 116	33266	28,840	1979	28440	159 028	116,364	2001	594535	317 800	234,794
1958	63 942	35015	30,676	1980	295,824	165 365	119 093	2002	653853	315 272	220 581
1959	67 337	36,552	32 322	1981	309888	172,909	122 915	2003	675802	322 009	211 666
		38			327				567		
1960	70,314	40,671	33,762	1982	345972	181,465	128,423	2004	496520	362,926	246 876
1961	73 509	44,314	35 238	1983	362824	191 052	136 020	2005	573344	359 044	208,476
1962	77,749	49009	37 071	1984	46379,5	200 477	144 845	2006	6272,9	303 092	193 091
1963	84 023	54,488	39,709	1985	418770	208 853	153,971	2007	63217	250,939	150,634
		60			443197				111		
1964	92 147	66,979	43 138	1986	468195	216,398	163 148	2008	266,619	206,420	138 044
1965	101 682	73,997	47,194	1987	493370	224 445	172,977	2009	222660	170 235	125 210
1966	112,199	89	51,693	1988	519,662	234 501	184 269	2010	281110	145,999	126,964
1967	123 576	104	56,597	1989	546436	246 463	196,734	2011	287191	110,578	106,533
1968	135,938		61,941	1990		259 055	209 140	2012		141,796	124 823
1969	149 111		67 605	1991		272,414	220 965	2013		117,459	105 210
1970	162,628		73,320	1992		287,386	232 276	2014		148,332	132,787
1971	175,836		78 732	1993		303 690	242 746	2015		145,860	141 331

Source: Calculated based on 4.11 and the 2000 and 2010 Mexican censuses.

Figure 4.5. Total emigrants from Mexico by sex, 1950-2015



Source: Table 4.12

such a short time. The total number of international emigrants is shown in Table 4.12 and Figure 4.5.

To avoid distortions in the age pattern when combining the patterns of the three components of the migration flow (Mexicans and foreigners to the United States and both to other countries), the age composition of Mexicans residing in the United States, as seen in the previous section, was superimposed on the overall flow for each year from 1990 to 2015. Dividing these emigrants by the average population from Chapter 2 yielded age-specific emigration rates. The 1990 rates were assumed to be the same for the previous 40 years, and multiplying them by the average population from Chapter 2 yielded the age structure that was superimposed on the total estimated for each year in

4.3 International immigration from Mexico

The immigration figures are easier to obtain, as they have been collected from various data sources in our country. Of these, we prefer population censuses because they provide complete national coverage and interview all residents.

In the censuses from 1960 to 1980, respondents were asked if they had lived in another federal entity or country; and, if the answer was yes, they were asked about the federal entity or country of their last residence and the length of time they had lived at their current residence. Serious deficiencies in the question in 1980 (Parí, 1993) led to its replacement with a simpler one starting in 1990:

the place of residence five years prior. The omission of migration occurring six years or earlier was remedied by including the question in the 2005 count, but not in 1995. Thus, international immigration (residence in another country five years prior) is available for the five-year periods 1985-1990, 1995-2000, 2000-2005 and 2005-2010, and from the Intercensal Survey for 2010-2015.

From Partida's estimates (1993), based on various published and unpublished tabulations of the 1980 census for the previous decade, the few published data from the 1970 census and samples of 1.5% of the 1960 census and 10% of the 1970 count, we developed the tabulations on immigration to our country.

However, due to the way data was collected in the 1990 and 2000 censuses, migration figures are unavailable for the five-year periods 1980-1985 and 1990-1995. For the five-year periods 1975-1980, 1985-1990, and 1995-2000, the proportion of immigrants from those periods relative to the total population at the end of the period was calculated. The proportions for the intervening five-year periods were estimated as the arithmetic mean of the five-year periods they cover. This estimate was made for each age group and sex separately. The proportions for 1980-1985 and 1990-1995 were multiplied by the average populations (Chapter 2) to determine the number of migrants who remained at the end of those periods. The amounts incurred were estimated using formulas (4.8), (4.9) and (4.10), as appropriate.

Unlike the 2000 United States census, which includes data for each year of immigrant arrival, the available data for Mexico are only available in five-year periods (Table 4.13).¹⁰ To break them down by individual years, the five-year totals were accumulated and, using *cubic spline interpolation, the results were combined*. (Burden and Paires, 1988: 134-147), the annual accumulation was obtained and, from there, the annual figures reproduced in Table 4.14.

Except for corrections to low or unacceptable (negative) values in 1950 and 2012-2014, the remaining amounts are derived from the annualization of the accumulated

$$7(1950) = 7(1951) \left(\frac{7(1951)^{-1/2}}{7(1952)} \right)^{1/2}$$

The square root of the subsequent increase is taken in order to maintain the 1950-1954 growth pattern. Together with the amounts deployed for 1951 to 1954, these were provided to the previously estimated total for the five-year period 1950-1954. Likewise, the annual figures for men were 107,301 in 2012, 57,475 in 2013, and -3,711 in 2014, and those for women were 66,245, 45,351, and 19,555, respectively—an extremely downward trend and an unacceptable value for men in 2014. We assigned the constant value of 60,000 for women in each year of the three-year period 2012-2014, and, together with the disaggregated figures for 2010 and 2011, all were provided to the previous five-year total. Finally, the total number of men from 2010-2014 was

¹⁰ The 1970 census was conducted on January 28—which we can equate to January 1. The classification of residence periods was: less than one year (1969), 1 and 2 years (1967-1968), 3 to 5 years (1964-6 to 10 years (1959-1963). If we assume that migrants were evenly distributed within each period, the flow from 1960 to 1964 is obtained as 4/5 of 1959-1963 and one third of 1964-1966; and from 1965 to 1969 as two thirds of 1964-1966 and the total of 1967 to 1969.

Period	Total	Men	Women
1950-1955	34 302	18,656	15,646
1955-1960	70,820	37 002	33,818
1960-1965	32211	16,858	15,353
1965-1970	69,380	35,933	33,447
1970-1975	109,825	59,912	49,913
1975-1980	402 544	255 771	146773
1980-1985	432055	251 391	180,664
1985-1990	439104	230,789	208 315
1990-1995	533 209	287,047	246162
1995-2000	603 955	330116	273 839
2000-2005	548 803	313 998	234 805
2005-2010	1,352,159	869 387	482 772
2010-2014	802 657	480 651	322 006

Source: Population Censuses 1960 to 2010, Population Count 2005 and Intercensal Survey 2015.

For the amounts of immigrants for 2015, we assumed that their value was the same as in 2014. The temporal pattern without ups and downs (graph 4.6) led us to accept the volumes derived from the accumulation of the five-year estimates.

It is now necessary to break down those annual amounts by age, which we will do using age-specific rates.

Let's denote by ${}_5L_{x,t}^c$ $P(t)$ be the number of people aged x to $x + 4$ residing in Mexico at time t , and let ${}_5P_x(t)$ be the number of immigrants who immigrated during the previous five-year period, where the superscript "c" indicates that it is a cohort or generation flow. If we subtract the immigrants from the population at the end, we have the inhabitants five years prior who did not emigrate. Since immigration increases the population size, the rates—annual average per capita—for the different five-year age

$$\frac{{}_5L_{x,t}^c}{{}_5P_x(t)} = \frac{{}_5P_x(t)}{{}_5L_{x,t}^c} \quad \text{and} \quad {}_5r_x^c = \frac{1}{5} \ln \frac{{}_5P_x(t)}{{}_5L_{x,t}^c} \quad x = 5, 10, \dots, 85 \quad (414)$$

where the first is divided by 2.5, because children aged 0-4 years in the census (time t) are exposed to migration, on average, only half of the five-year period (from birth to the end).

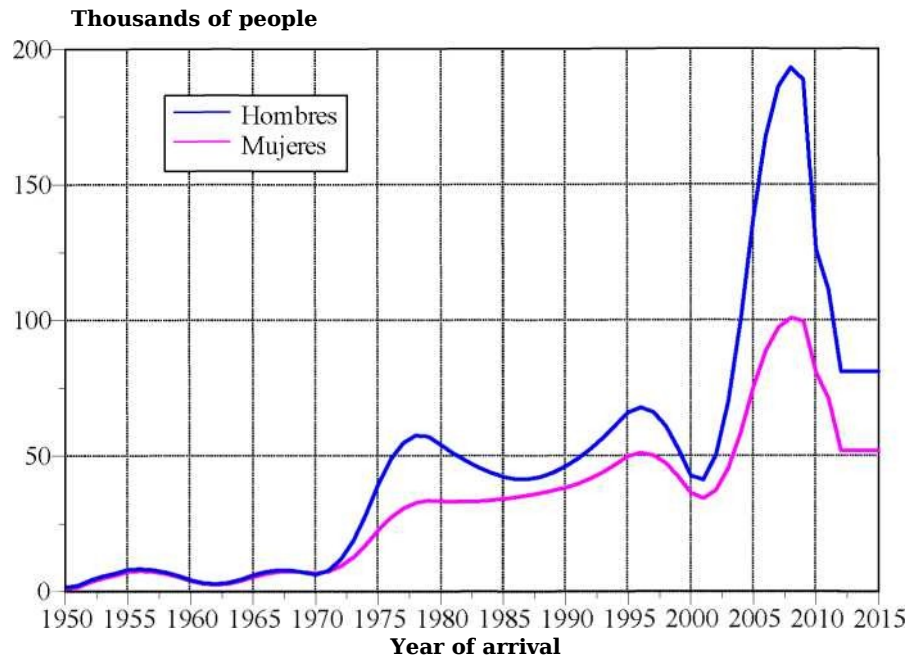
If we assume that the rate is constant at all ages in the cohort during the

$${}_5L_0 = 7 \cdot {}_5L_4 + 5 \cdot {}_5L_9$$

the 5-9 year olds:

Year	Total	Men	Women	Year	Total	Men	Women	Year	Total	Men	Women
1950	2,457	1,484	973	1972	21 034	11,741	9293	1994	108 147	61 310	46,837
1951	3 541	2072	1,469	1973	31 155,3	18,607	12,548	1995	1156 118,6	65,886	49,724
1952	7,385	4042	3343	1974	45,3 42	28 217	17,126	1996	116 27	67 673	50,954
1953	10,359	5,560	4,799	1975	62 169	39,579	22,590	1997	101 108	66,000	50 101
1954	12,466	6,631	5835	1976	75,9 59	48,740	27 219	1998	94 029	60 864	47,165
1955	15 232	7987	7 245	1977	85 293	54,713	30,580	1999	411 78	52,265	42,146
1956	15,643	8 175	7,468	1978	90 167	57,495	32,672	2000	70 75	42,552	36 238
1957	15 091	7 868	7 223	1979	90 584	57,088	33,496	2001	336 87,58	41 117	34 219
1958	13,570	7065	6 505	1980	87,3 84	54,089	33 295	2002	7 115,5	50 306	37 281
1959	11,088	5,769	5319	1981	83,9 48	50,895	33 053	2003	47 159	70 122	45,425
1960	8029	4 180	3849	1982	81 112	48 103	33 009	2004	213 213	100 562	58,653
1961	5,975	3 122	2853	1983	78 981	45,714	33 167	2005	258 256,3	137,962	75 296
1962	5314	2,798	2516	1984	77 252	43,727	33,526	2006	72 283	167,666	88 706
1963	6047	3207	2840	1985	76 272	42 207	34 065	2007	220 293	186 008	97 212
1964	8 174	4351	3823	1986	76 124	41 412	34,712	2008	810 288	192,989	100 821
1965	11,274	5997	5 277	1987	951 76	41,406	35,445	2009	137 206,4	188,610	99 527
1966	13,680	7 228	6,452	1988	78 452	42,189	36 264	2010	26 181,8	125,915	80 511
1967	14,963	7809	7 154	1989	8093 3	43,762	37 171	2011	88 132,7	110,947	70,941
1968	15 133	7,744	7,389	1990	84 313	46,087	38 226	2012	02 132,7	80,945	51,757
1969	14,184	7032	7 152	1991	88 700	49,026	39,683	2013	02 132,7	80,945	51,757
1970	12,978	6 235	6,743	1992	94 147	52,543	41,604	2014	02 132,7	80,945	51,757
1971	14,976	7,617	7,359	1993	100,6 26	56,637	43,989	2015	02 132,7	80,945	51,757

Source: Calculated based on Table 4.13.

Figure 4.6. Total immigrants from Mexico by sex, 1950-2015

Source: Table 4.14

$$5_{\text{L}}5 = - [5_{\text{L}}5 + 5_{\text{L}}10]$$

and in general:

$$5_{\text{L}}5 = - 2 [p^{< x + 5} + 5] \quad (4-15)$$

The principle is shown schematically in the Lexis diagrams in Figure 4.2.

The breakdown by single ages was done as follows. The rates were accumulated in a manner similar to a total fertility rate:

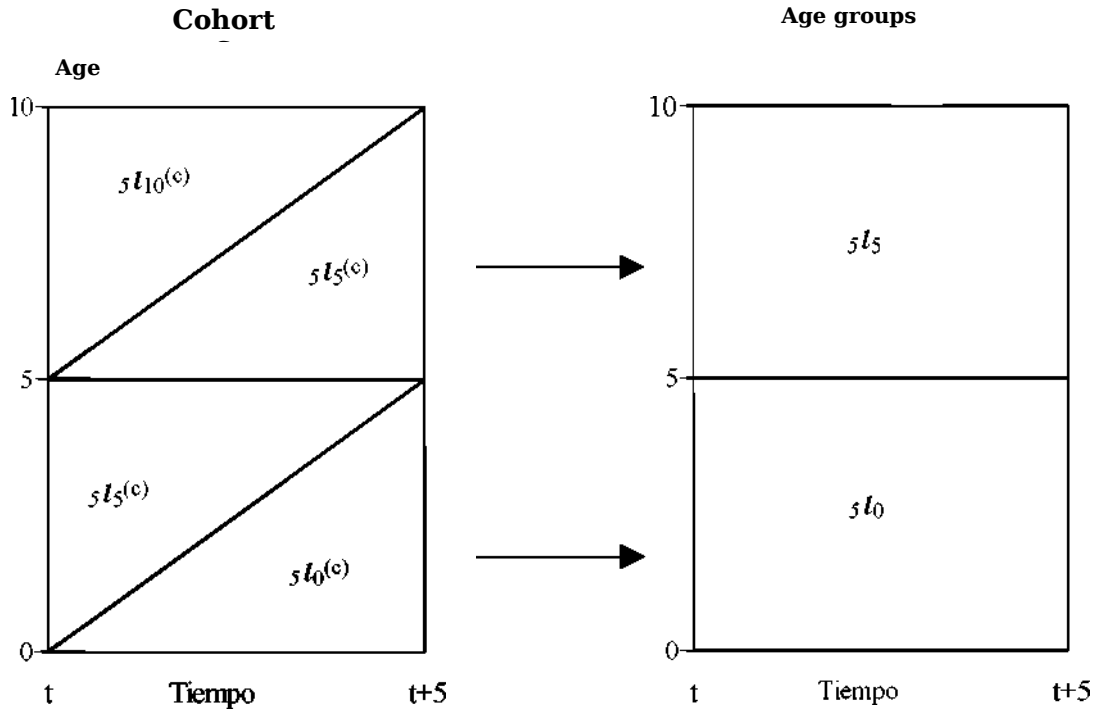
$$G(0)_x = 0$$

$$G(x) \equiv \sum_{t=x-5}^{x-1} \text{rate}_t \quad \text{for } 5 < x < 90$$

and = 0

where the summation index increases by five and it is assumed that there is no migration after age 90. By interpolation with **cubic spline functions** (Burden and Faires, 1988: 134-147) the accumulation is obtained for each exact integer age, and the rates by unfolded age are simply:

Lexis diagrams illustrating the transition from cohort rates to age groups



$$i_x = G(x + 1) - G(x)$$

$G(x + 5)$ are maintained and, therefore, the closure property is satisfied:

$$\frac{5LE}{y=0} = \frac{\hat{\wedge}^4}{\hat{\wedge}^5} L'x+y$$

We located the rates at the midpoint of the five-year period (1952, 1957,..., 2007 and 2012). For the intervening years, we interpolated them linearly for each age separately and assumed them to be constant at the extremes; that is, the rates from 1950-1955 for 1950 and 1951, and those from 2010-2015 for 2013, 2014, and 2015. As with emigrants, we multiplied them by the average populations (Chapter 2), and the resulting age structures were superimposed on the annual totals (Table 4.14). The age-specific immigrants thus estimated were divided by the average population to obtain the final rates, which, like the emigration rates, were used in estimating the mortality level

5. Intercensal reconciliation of the population of Mexico

Various mathematical and demographic analyses reveal that Mexico's thirteen modern population censuses (1895 to 2010), the 1995 and 2005 counts, and the 2015 intercensal survey suffer from age misreporting and insufficient coverage. Although both deficiencies have diminished over time, they are still present in the most recent population enumerations. While the presence of these two flaws is clear, it is generally difficult to determine the degree of error separately, as both are intertwined in the population's age structure. For example, the presumed undercounting of women in the 40-44 age group may be due more to a rejuvenation resulting from age misreporting than to an omission in the census count.

Traditional intercensal reconciliation exercises consist of simultaneously locating, at a single point in time, the population of two or more censuses, using demographic projection and retrospection procedures. Once the different populations counted at a given time have been located, the expert chooses—for each age and sex—the one that, in their judgment, is the most appropriate; finally, the selected population is placed at the initial point in time of the projection (Rincón, 1984).

One limitation of this procedure is that it generally attempts to correct both age misreporting and coverage problems simultaneously, which can introduce a degree of arbitrariness in selecting a population from among the various available ones. An alternative is to first address the deficiencies stemming from incorrect age reporting in each census and then, using temporal matching, select the enumeration with the greatest degree of completeness. In this regard, the work of Luther and Retherford (1988) is worth mentioning. They designed an algorithm, with a certain degree of mathematical complexity, that allows for the simultaneous correction of both the events that comprise demographic evolution and the populations counted in the census. The procedure consists of assigning a different correction factor to each piece of information. These factors are the unknowns in a set of linear equations, structured for each generation, based on the principle of the balancing equation or demographic balance. Because the number of unknowns is at least twice the number of simultaneous equations, the solution is not unrestricted, and initial correction factors must be introduced. The algorithm seeks to minimize the distance between the final correction factors—within the space of possible solutions—and the initial ones, which lie outside that space. Since the result depends largely on the initial values assigned to the unknowns, it is clear that this

The procedure also involves a certain degree of arbitrariness, even when the initial data has already been corrected for problems of misreporting age.

In Mexico, population counts prior to 1990 have been subject to post-census adjustments due to omissions in fieldwork, although information on these adjustments is only available for the 1980 census. An intercensal reconciliation might be measuring the sensitivity of the adjustments in previous counts rather than the coverage of the 2015 intercensal survey. Similar methodologies and operational structures were used in the Mexican censuses of 1990, 2000, and 2010, and in the 1995 and 2005 counts, so similar errors are expected, at least from a coverage perspective.

As in ordinary methods of intercensal reconciliation, it is not possible to completely separate the error attributable to the misstatement of age from that corresponding to the omission; in chapter 2 the misstatement of age was corrected, here we deal with rectifying the omission in the censuses from 1950 to 2010 and the counts of 1995 and 2005 and the survey of 2015, by the demographic reconciliation of those sixty-five years with the age structure of 2015.

5.1 Demographic reconciliation 1950-2015

The reconstruction of mortality, fertility, and international migration, in chapters 2, 3, and 4, allows us to simultaneously assess the coverage of the ten population enumerations considered. To do this, we use the standard methodology for making population projections. The reconciliation of demographic trends from 1950 to 2015 with the population corrected for undercounting is done using single-age data to ensure the greatest possible accuracy.

Let $P_{(x)}(t)$ denote the population of age x at time t and $S_{(x)}(t)$ denote the proportion that will remain in the country one year later, that is,

$$P_{x+1}(t+1) = P_x(t)S_x(t) \quad (5.1)$$

and for children under one year old:

$$P_0(t+1) = B(t)S_b(t) \quad (5.1')$$

where $B(t)$ refers to the births that occurred during the year starting at t .

It is clear that the proportion $S_x(t)$ incorporates both mortality and international migration. If $Sa_x\{t\}$ expresses survival to mortality and $S|_x(t)$ the growth or decline factor due to net international migration, it is clear that, under the assumption of stochastic independence between mortality and migration, we have:

$$S_x(t) = S_{teit}(t) S_{xx}(t) \quad (5.2)$$

$S_d(t)$ and $S|_x(t)$ are valued as:

$$S_d(t) = \frac{P_{x+1}(t+1)}{P_x(t)S_{xx}(t)} \quad (5.3)$$

where $L_x(t)$ are the person-years lived at age x in the life table for year t , which are derived from the mortality estimates in Chapter 2, and $A_x(t)$ is the net migration rate for year t obtained in Chapter 4. For those born during the year:

$$Sdb(t) = \sum_j s_{xb}(t) = \frac{\exp j^{\wedge} j}{(5.3')}$$

where $l_0(t)$ is the radix of the life table.

The formulas for survival are widely known; those for migration have the following explanation. Net migration rates are of the age-period type, i.e., the Lexis diagram on the right side of Figure 4.2, and we need to convert them into cohort-period rates, i.e., the Lexis diagram on the left side of Figure 4.2. Children aged 0 years at the end of the year are exposed, on average, for only half the year (lower triangle on the left side of Figure 4.2), which is why half of A_0 is taken in (5.3'); and people aged $x + 1$ years at the end are exposed, on average, for half a year of their completed age. at the exact age $x + 1$ (A_{x+}) and half a year from the exact age $x + 1$ to the completed age $x + 1$ (A_{x+i}), as can be seen in the Lexis diagram on the left side of Figure 4.2, so the risk is the average of A_j and A_{j+i} .

Births, which are added year after year, are obtained from their mothers. Let $F(t)$ denote the **fertility rate during** the year starting at t for the group.

five-year period of completed ages i to $i + 4$. If ${}_5P_i(t)$ is the female population at mid-year, that is,

$${}_5P_i(t) = \frac{1}{5} [{}_5P_i(t) + {}_5P_{i+1}(t)]$$

Births from that age group are:

$${}_5B_x(t) = {}_5P_x(t) {}_5F_x(t) \quad (5.4)$$

and the total number of births is:

$$B(t) = \sum_{x=lb}^{45} {}_5B_x(t) \quad (5.5)$$

The age-specific fertility rates ${}_5F_x(t)$ were obtained in Chapter 3 (Table 3.5), and the index of the summation increases by 5.

The projection is made for each sex separately, so it is necessary to disaggregate births by sex. In countries with reliable vital statistics, it has been shown that more males are born and that, in long-term trends, the sex ratio at birth ranges between 103 and 106 males per 100 females. In Mexico, among births occurring and registered during the first five years of life for the 1985-2010 generations, brought to the time of delivery through retrospection (see section 3.1), the ratio varied annually from 103.7 to 104.9, with a mean of 104.3, but only a standard deviation of 0.3, and a median of 104.4. Based on these indicators, we adopt a sex ratio at birth of 104.

We began the reconstruction with the 2015 intercensal survey, whose average data collection date is March 15. In order to simplify the procedure, and to match

Temporarily, our annual estimates of mortality, fertility, and international migration from the three previous chapters, we opted to use the population at the beginning of 2015. The population as of January 1, 2015, was obtained by the arithmetic mean of the mid-year populations of 2014 and 2015 estimated in Chapter 2. The procedure was done for each single age and sex separately.

In order to inspect the coverage of the most recent population counts, a population retrospective was made from 2015 to January 1, 1950. The retrospective consists of a reconstruction of the past, say an inverse projection, which is obtained by solving in equations (5.1) and (5.1')

$$P_x(t) = \frac{P_{x+l}(t+1)}{S_x(t)} \quad \text{and} \quad B(t) = \frac{P_0(t+1)}{S_b(t)} \quad (5.6)$$

Applying the left-hand side equality in (5.6), the number of people aged 109 on January 1, 2014, is zero, because we assume that the number of women aged 110 on January 1, 2015, is zero, because we have assumed that no one reaches 110 years of age. To “recover” this elderly population, which is lost when performing the retrospective analysis, we use the populations estimated in Chapter 2. Let us define the ratio of these populations at time t as:

$$W_t = \frac{P_{98}(t)}{P_{108}(t)} \quad (5.7)$$

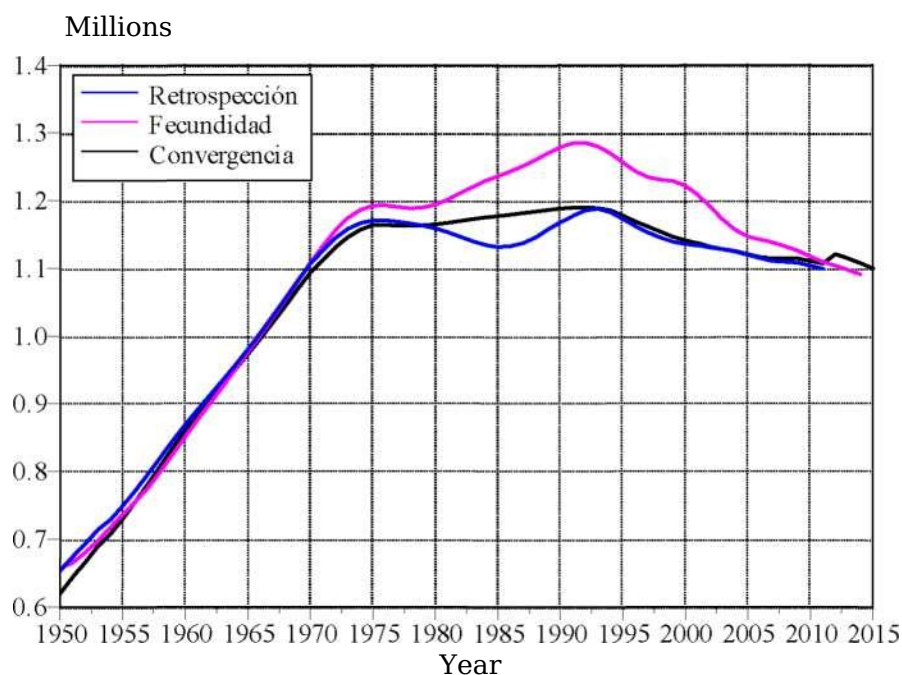
These figures, for January 1st of each year in the period 1950-2014, are assimilated to the corresponding mid-year figures from the interpolation of the age structures in section 2.2.3. By retrospectively looking at the 99-year-old women in 2015, we obtain the 98-year-old population in 2014, which, by solving in (5.7), gives the 99-year-old population as $P_{99}(2014) = P_{98}(2014) \times W_{98}(2014)$, and so on until completing the population aged 99 to 109 years in 2014. The algorithm is repeated for all previous years. We start at 98 years, and not only at 108, because the low population figures at such advanced ages are magnified when going back in time; Starting at 98 years, reasonable figures are obtained for the extreme advanced ages.

Only the population aged 3 years or older is considered, because, as explained in Chapter 1, the different census omission of children compared to the rest of the inhabitants in Mexico only takes place in the first three years of life.

From the valuation using the equation on the right in (5.6), we obtain a historical series of births. An additional series is obtained by superimposing the fertility rates from Chapter 3 onto the women of childbearing age generated through retrospective analysis. The two series are presented in Figure 5.1. It can be seen that, although both time patterns are similar, the trend differs between 1981 and 2004, that is, in the cohorts corresponding to women aged 10 to 33 years at the beginning of 2015.

Comparing the population as of January 1, 1950, obtained through retrospective data with the census data, adjusted and smoothed in section 2.2.2, we found a clear agreement in the population figures up to age 30. However, from age 30 to 89, the retrospective data significantly exaggerated the number of women. We then superimposed the age composition of the adjusted census data, starting from age 31, onto the retrospective population data, and

Figure 5.1. Female births estimated by cohort reconstruction and with fertility rates, 1950-2015



Source: Estimates based on chapters 2, 3 and 4.

Using these women as the base population, we carried out a demographic projection from 1950 to 2015. By linearly interpolating the populations on January 1, 2015 and 2016, for each age separately, we estimated the population on March 15, 2015, the mid-date of the intercensal survey.

Previous demographic reconciliations carried out for the country (Partida 2003, 2008; SOMEDE, 2011) concluded that coverage of the female population is better than that of the male population, and that data integrity has improved over the years. The estimated population aged 3 years and over as of March 15, 2015, was 58,399,534 compared to the enumerated population of 58,445,649. Thus, we multiplied the population on January 1, 1950 by the factor $1.000790 = 58,399,534/58,502,371$. The estimated population was now 58,445,664, that is, 15 people less than the one enumerated, with which two births were subtracted from the total from 2006 to 2012 and in this way the total of women aged 3 years or older enumerated in the 2015 survey was obtained.

The births derived from the retrospective analysis—included in Figure 5.1 as “convergence”—imply slight modifications to the fertility levels estimated in Chapter 3. It is therefore necessary to obtain the new age-specific rates, which, when superimposed on the estimated female populations, yield the same birth figures as the reconciliation. To do this, let us denote the fertility calendar by s/y ; - (/), that is:

$${}_5 9x(t) \frac{{}_5 r_x F_x(t)}{-----}$$

where **TGF** is the total fertility rate:

$$TGF = \frac{{}_5 \sum_{x=15}^{45} F_x(t)}{}$$

and the index of the summation increases by 5.

If we retain the calendar and only modify the level of mortality, the new rates should be the original rates modified by a proportionality factor **k**:

$${}_5 F_x(t) = k {}_b F_x(t) \quad (5.8)$$

For new births, according to equations (5.4) and (5.5):

$$B(t) = \sum_{x=15}^{45} a {}^B x(t) = \sum_{x=15}^{45} {}^2 P_x(t) k {}_b F_x(t) = k \sum_{x=15}^{45} {}^2 P_x(t) {}_b F_x(t)$$

where from:

$$k = \frac{B(t)}{\sum_{x=15}^{45} {}^2 P_x(t) {}_b F_x(t)} \quad (5.9)$$

and with that factor, the adjusted fertility rates are obtained using (5.8). Figure 5.2 compares the new overall fertility rates with the original ones from Chapter 3. The differences are somewhat marked, especially before 1970 and after 1985, although the levels are reasonable throughout the 66-year period.

We reconciled the male population using the masculinity index. As mentioned above, we adopted the birth rate of 104 males per 100 females for all years of the period 1950-2015; this covers the first sixty-five age groups, since we have mortality reconstruction data and international migration data from 1950 to 2015. Therefore, an estimate of the masculinity index for 1950 is necessary, as these men constitute the male population aged 65 to 109 in 2015, which we obtained using a similar approach to that used for the stationary population in the mortality table.

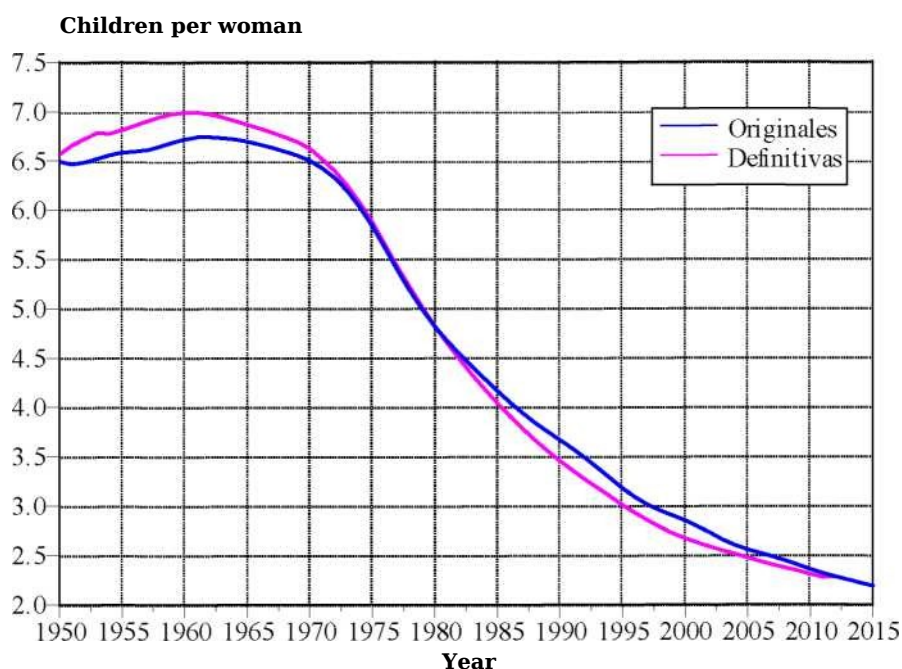
If we solve for the stationary population in the first equation in (5.3) we get the stationary population of the life table:

$$L_x + i\{t\} = S_{dx}(t) \underline{L}_x(t)$$

and, by similarity, incorporating (5.2):

$${}_x F + i\{t\} = S_x(t) {}_x F(t) \quad (5.10)$$

Figure 5.2. Original and final global fertility rates, 1950-2015



Source: Estimates based on chapters 2, 3 and 4.

where now $C_x \{i\}$ is the stationary population with mortality and migration. If we adopt a unit radix in the equation on the right-hand side of (5.3), we have $Co(t) = \ll S_{\ell}(i)$, and by

successively applying (5.10) we obtain the stationary population for the entire age range. The

masculinity index for 1950 is obtained as:

$$7114(1950) = 1.04 \times \frac{P^m(1950)}{P_f(1950)}$$

where the superscript m indicates the male population and f the female population. The total population as of January 1, 1950 is, therefore:

$$P^{TM}(1950) = 7114(1950) \times P_f(1950)$$

Using the projection procedure of formulas (5.1) and (5.1'), the male population from 1950 to 2015 was reconstructed.

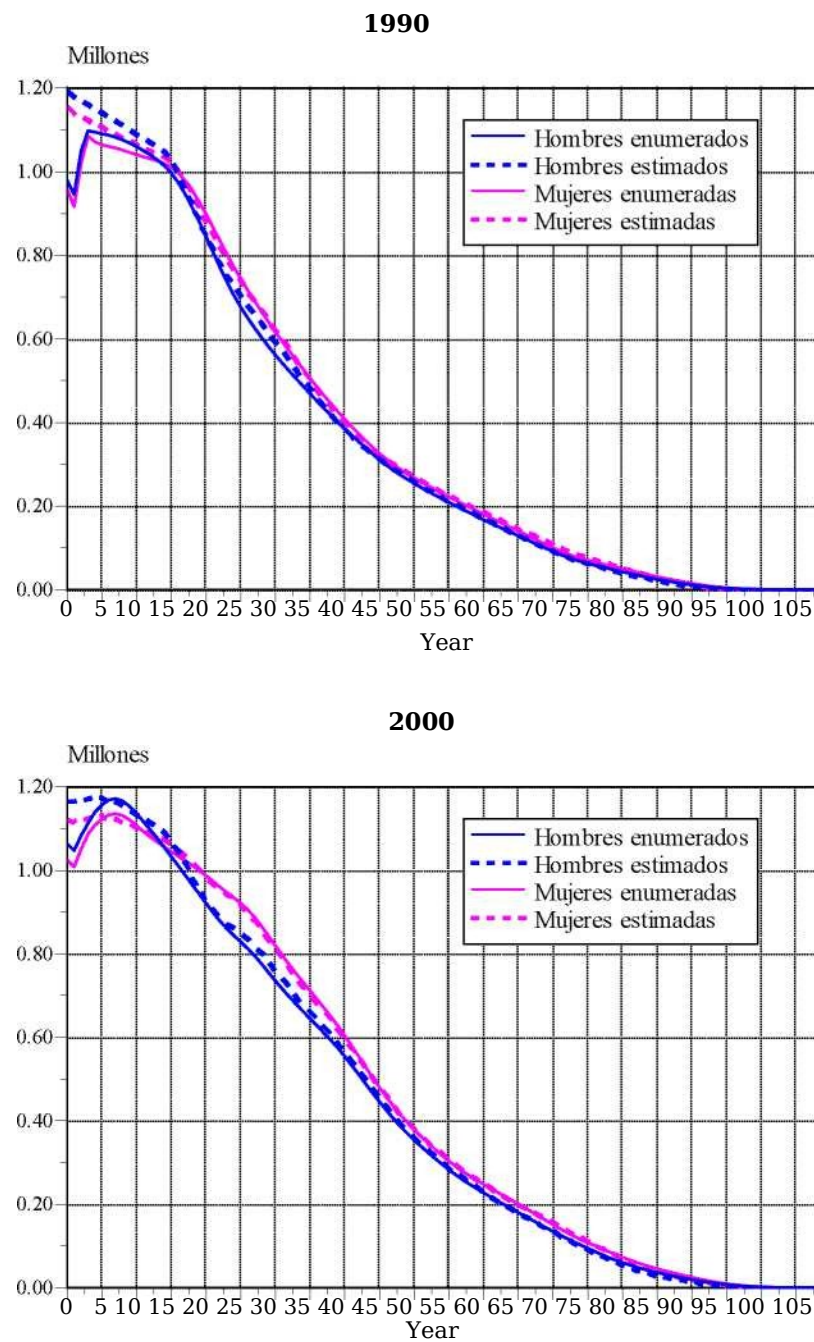
Table 5.1 presents the estimated population as of January 1, 2016, which would serve as the base population for any future population projections for Mexico. Appendix G provides the population, by age group and sex, from January 1, 1950, to January 1, 2016.

Figure 5.3 compares the enumerated and estimated populations from the censuses of 1990 to 2010 and the 2015 survey. A strong consistency is observed in the age

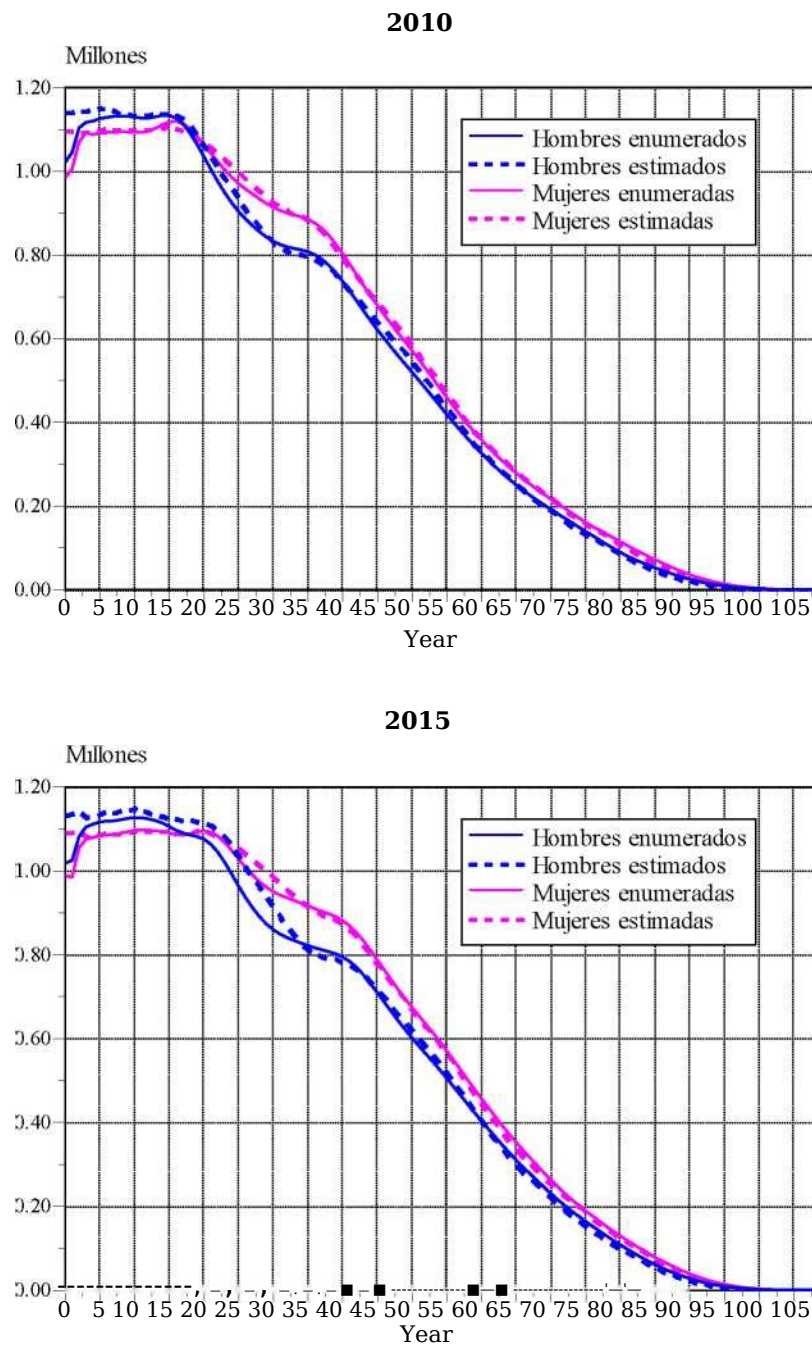
Age	Men	Women	Age	Men	Women	Age	Men	Women	Age	Men	Women
0	1,124,924	1,085,019	28	973 888	1,021,284	56	508 593	555 432	83	73,981	98 059
1	1,127,304	1,088,801	29	949 369	1 007 031	57	485 531	531 507	84	65 852	88 304
2	1,128,502	1,090,816	30	925 672	992 676	58	462 502	507 526	85	58 041	78 774
3	1,130,182	1 091 801	31	902 108	978 923	59	439 483	483 458	86	50 532	69,449
4	1,130,930	1,091,950	32	878 713	963 507	60	415 458	458 932	87	43,371	60,385
5	1,131,813	1,092,898	33	856 725	949 439	61	392 435	435 323	88	37 127	52,389
6	1,133,681	1,094,132	34	836 841	935 813	62	369,840	412 386	89	31 151	44,555
7	1,135,548	1,096,524	35	819 932	923 901	63	348 389	389 358	90	26,070	37 801
8	1,136,664	1,097,725	36	806 687	911 780	64	326 366	366 344	91	21,546	31,672
9	1,139,199	1,099,081	37	796 918	901 569	65	305 344	344 328	92	17,526	26 108
10	1,142,307	1,101,818	38	790 251	892 740	66	289,783	898 310	93	14 021	21,160
11	1,143,806	1,103,433	39	786 410	885 822	67	272 310	310 293	94	11 014	16,830
12	1,140,476	1 101 039	40	784 545	872 807	68	255 293	293 276	95	8,482	13 113
13	1,135,582	1,098,413	41	778 929	866 065	69	239,927	276 260	96	6,396	9999
14	1,131,278	1,096,966	42	770 747	851 601	70	224 264	260 706	97	4,716	7,455
15	1 126 120	1,094,711	43	759 155	834 210	71	210 245	245 631	98	3402	5,427
16	1,121,760	1,091,664	44	744 237	814 284	72	195,882	230 704	99	2,395	3852
17	1,118,806	1,088,806	45	726 582	792 260	73	182,417	216,771	100	1,641	2,658
18	1,116,046	1,087,659	46	707 964	770 896	74	170 203,98	203,981	101	1089	1,778
19	1,113,569	1,088,801	47	688 250	747 650	75	157,472	190,678	102	699	1,146
20	1,111,617	1,090,874	48	668 173	724 993	76	145 177,43	177,433	103	431	708
21	1,108,247	1,091,166	49	648 403	703 982	77	133 164,61	164,610	104	253	417
22	1,099,882	1,087,064	50	629 160	682 140	78	121 152,42	152,420	105	141	232
23	1,087,605	1,080,855	51	610 109	661 130	79	111 140,70	140,709	106	73	121
24	1,070,211	1,072,251	52	590 911	641 281	80	101 112	129,430	107	36	59
25	1,046,730	1,059,774	53	571 457	620 272	81	91 586	118,630	108	16	27
26	1,021,888	1,046,489	54	551 367	599,932	82	82,560	108 104	109	7	11
27	998 450	1,034,574	55	530 435	578 162						

Source: Estimates based on chapters 2 to 4.

Figure 5.3. Population enumerated and estimated by age and



**Figure
5.3.**



Source: Estimates based on chapters 2, 3 and 4.

years of life, as we have pointed out before, and in men between 15 and 35 years of age, presumably because temporary migration entails some omission, although the country's population counts have been *de jure* since 1930.

Table 5.2 compares the reconstructed populations with the census data for the ten counts considered. The accuracy of the population count has improved over the years, with the 2015 count having the best coverage. The 2005 count, perhaps due to the lack of a post-census housing verification survey, shows greater undercounting than the 2000 and 2010 censuses, between which it falls. It is worth noting that efforts to count children under 3 years of age, traditionally excluded, have been successful, as the proportional undercounting of these children is decreasing.

Three facts in Table 5.2 are certainly noteworthy. First, the omission of women aged 3 and over in the 1950 census was less than in the 1970, 1980, and 1990 censuses, while it was greater for men. This may be due to the uncertainty surrounding international migration prior to 1960, as it was a rare phenomenon, especially among women, and the available information comes from sample surveys of only a few cases. Second, the negative values for people aged 3 and over in the 1980 census suggest that the population may have been overcounted. The fact is that, faced with serious problems during the data collection, when large areas of the country were not counted, "complementary techniques were applied" (Jarque, 1990: 7).

Third, the negative value for women aged 3 years or older in 2000. While this amount would imply over-enumeration in the census, we must consider that, of the 1,770,825 people that we attribute to 425,724 pending dwellings in the census, 783,684 were assigned to women aged 3 years or older, and added to 45,876,560 enumerated, yields 46,660,244. If we accept that the coverage of the 2000 census was total (enumerated plus assignment of pending dwellings), the female population "enumerated" aged three years or older would be 36,144 fewer women, that is, 46,062,410 (the result of the reconciliation); Or, we should have allocated 747,540 (783,684-36,144) for the pending housing, 4.6% of the original value.

5.2 Population growth trend

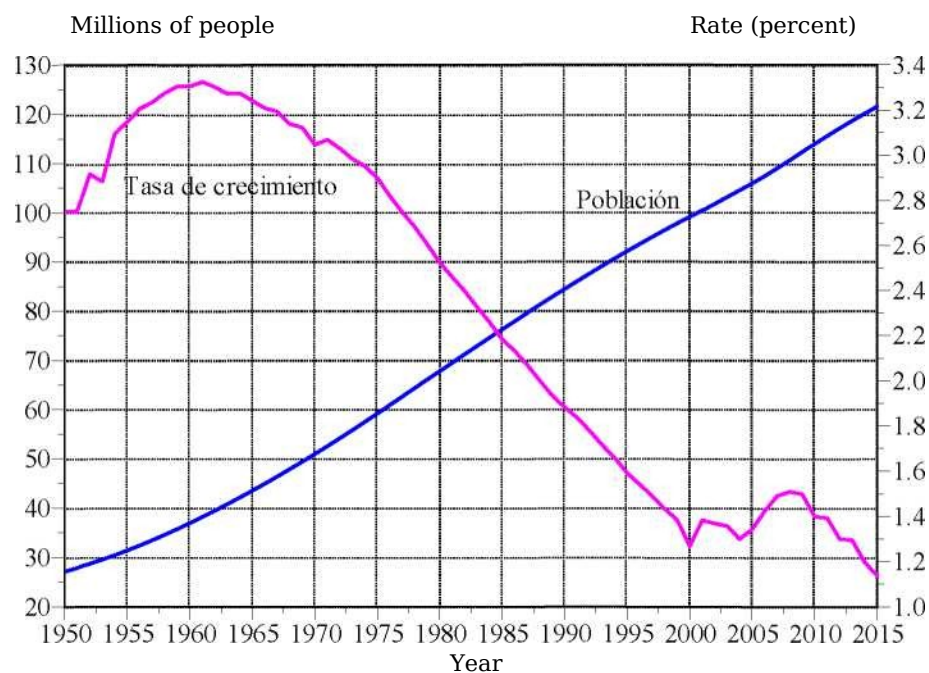
The average population and growth rates are presented in Figure 5.4. The country's population doubled in less than 30 years, rising from 27.1 million in 1950 to 54.2 million in 1972, and would have doubled again to 109 million in 2007; however, it is unlikely that the country's population will double again in the distant future. The growth rate, after a continuous increase for just over the first decade, experienced a marked decline, largely due to the reduction in the birth rate in response to the new population policy that promoted family planning from 1974 onward, and to a lesser, though still significant, degree, due to the growing net loss from international migration. The fluctuations in the growth rate so far this century reflect the behavior of international migration more than birth and death rates.

¹ 45,731,962 listed plus 144,598 by proportional distribution of non-response.

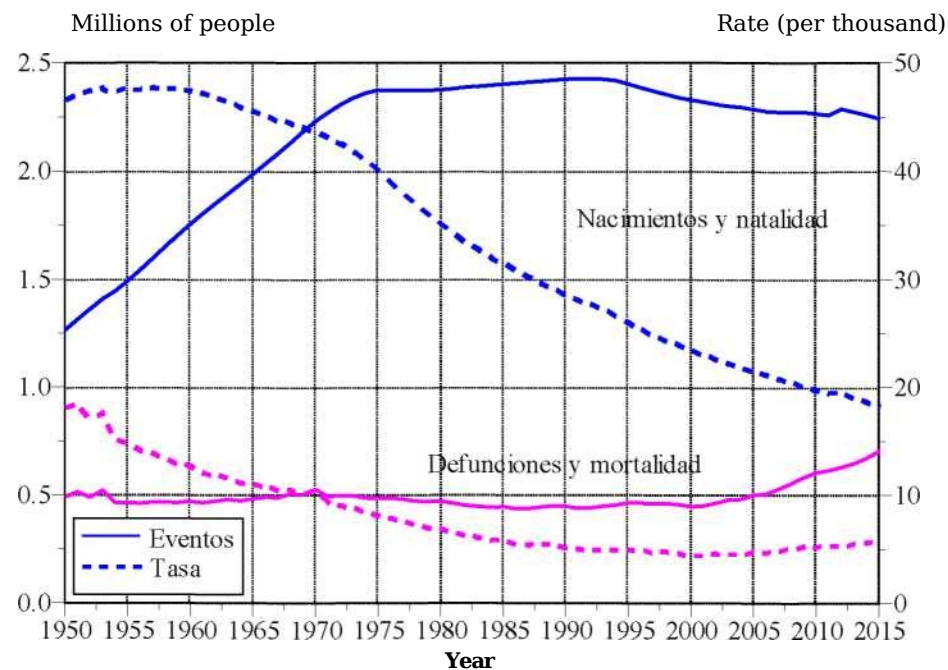
Sex	Census			Dear			Omission			Omission percentage		
	Total	0 to 2 years	3 years or more	Total	0 to 2 years	3 years or more	Total	0 to 2 years	3 years or more	Total	0 to 2 years	3 years or more
1950 Census												
Total	25,790,055	2 335	23 455	26 972	3 091	835 23 880	1,181,627	756 402	425	4.4	24.5	1.8
Men	12 696	1,179,133	11,516,9	13 468	746	1,561,575	771	381 632	324	5.7	24.4	3.3
Women	13 094	1,155,420	11 938	13 503	1 530	260 11 973	409	374,770	307	3.0	24.5	0.3
1960 Census												
Total	34 923	3,386	31 536	36 704	4 489	529 32 215	1,781,790	1,102,950	678	4.9	24.6	2.1
Men	17 415	1,729,570	15,686,1	18 349	2 273	218 16 076	934	544 024	390	5.1	23.9	2.4
Women	17 507	1,657,385	15 850	18 355	2 216	311 16 138	847	558,926	288	4.6	25.2	1.8
1970 Census												
Total	48 225	4 802	43 423	50 118	5 872	059 44 246	1,893,450	1,069,920	823	3.8	18.2	1.9
Men	24 065	2,440,126	21 625	25 062	2 974	909 22 087	996	534 624	462	4.0	18.0	2.1
Women	24 159	2,361,851	21,797,7	25 056	2 897	150 22 159	896	535 299	361	3.6	18.5	1.6
1980 Census												
Total	66 846	5 313	61 532	67 426	6 685	954 60 740	579	1,371,990	- 792	0.9	20.5	-1.3
Men	33 039	2,674,961	30 364	33 578	3,390	285,301,882,4	539	715 345	- 176	1.6	21.1	-0.6
Women	33 807	2 639	31 168	33 847	3 295	669 30 552	40 235	656 648	- 616	0.1	19.9	-2.0
1990 Census												
Total	81 281	5,867,723	75 414	83 679	6 952	332 76 727	2,398,086	1,085,050	1 313	2.9	15.6	1.7
Men	39 909	2 974	36 934	41 402	3 531	919 37 870	1,493,206	557,696	935	3.6	15.8	2.5
Women	41 372	2 893	38 479	42 277	3 420	413 38 856	904	527 363	377,514	2.1	15.4	1.0

Sex	Census			Dear			Omission		Percentage of omission			
	Total	0 to 2 years	3 years or more	Total	0 to 2 years	3 years or more	Total	0 to 2 years	3 years or more	Total	0 to 2 years	3 years or more
1995												
Total	7			3								
	91	6 173	84 986	9 4	7 006	966 85 338	1,185,		352			
	159	456	338	2 5	520		833 510	010	1.3	11.9	0.4	
Men	44	1 3 144	41 756	4 5	3 563	599 41 988	650		231	1.4	11.8	0.6
Women	46	6 173	43 229	4 5	3 563	367 43 350	534	419 429	231			
	258	286	356	6 9	788	063		414 081	120,707	1.1	12.0	0.3
2000												
Total	8	6 278	90 876	9 0	census 6,847,287		1,152,		583			
	154	266	622	8 7	91 460 257	44 836	751	569 021	730	1.2	8.3	0.6
	47,41	3 194	44 216	4 3	3 487	960 44 836	913		619	1.9	8.4	1.4
Men	47	3 084	46 660	4 9	3 359	327 46 624	239	293,757	631	0.5		
Women	49	063	244	9 8	100		120	275 264	974		8.2	0.1
2005												
Total	0	5,937,	96 794	1 0	Count		3,353,		2,538,1			
	732	690	398	6 5	6 752	809 99 332	262	815 119	43	3.2	12.1	2.6
	49,96	3 021	46 940	1 9	3 436	819 48 483	1,959,		1,543,6	3.8	12.1	3.2
Men	52	2,916,	49 854	5 1	3 315	990 50 848	1,393,	415,696	994			
Women	57	567	378	4 6	834		879	399 423	456	2.6	12.0	2.0
2010												
Total	5	6 230 917	106 206	1 6	Census		1,218,		721			
	112,4	652		1 5	6 728	195 106 928	968	497 278	690	1.1	7.4	0.7
	37	3,169,	51 717	3 6	3 421	853 52 204	739			1.3	7.4	0.9
Men	54	866	54 489	5 0	3 306	342 54 724	479,	251,987	487,096			
Women	57	3 061	434	8 3	028		885	245 291	234,594	0.8	7.4	0.4
2015 Survey												
Total	7	6 154 074	113 376	9 4	6 664	768 114 265	1,399,					
	11953	679		1 0	654		669	510 694	888 975	1.2	7.7	0.8
	0	3 125	54 931	1 2	3 390	111 55 820	1,153,			1.9	7.8	1.6
Men	58	1 028	58 445	6 7	3 274	657 58 445	245	265 008	888 975	0.4	7.5	0.0
Women	61	971	649	1 2	649		686	245 686	0			

Source: Estimates based on chapters 2 to 4.

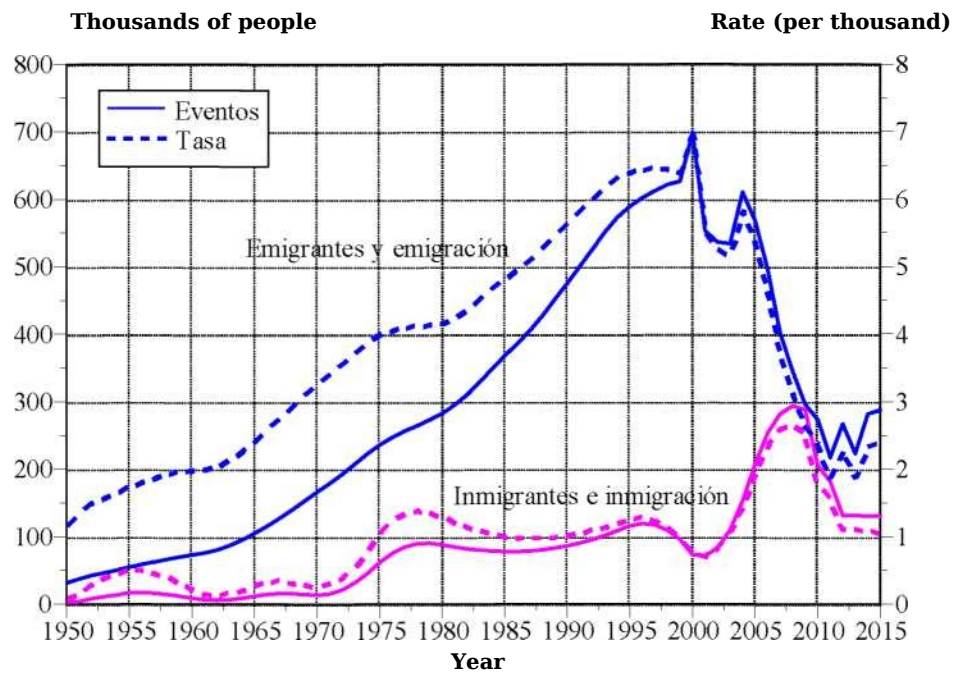
Figure 5.4. Average population and growth rate, 1950-2015

Source: Estimates based on chapters 2, 3 and 4.

Figure 5.5. Births, definitions and crude birth and death rates, 1950-2015

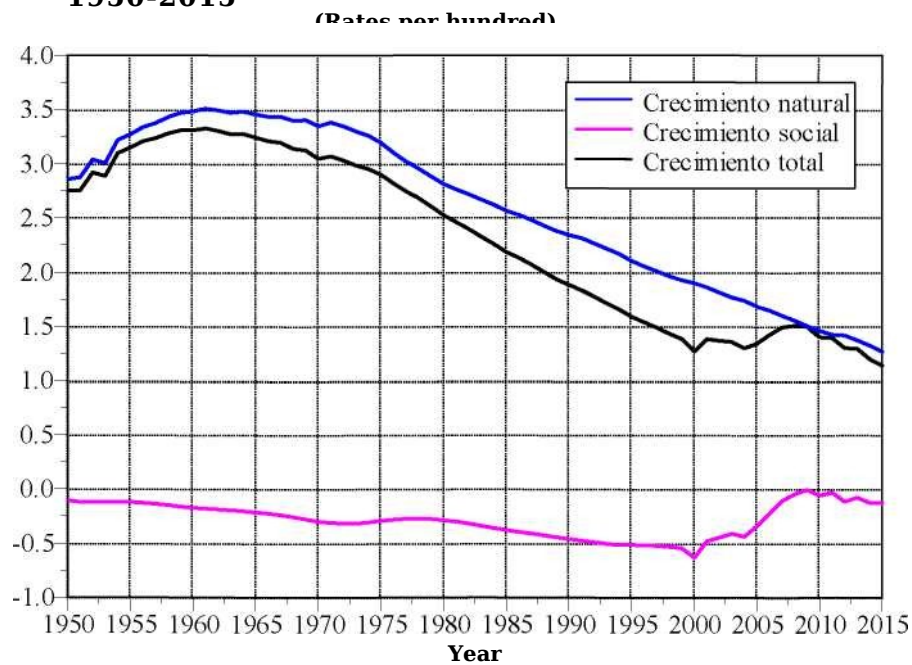
Source: Estimates based on chapters 2, 3 and 4.

Figure 5.6. International migrants and gross migration rates



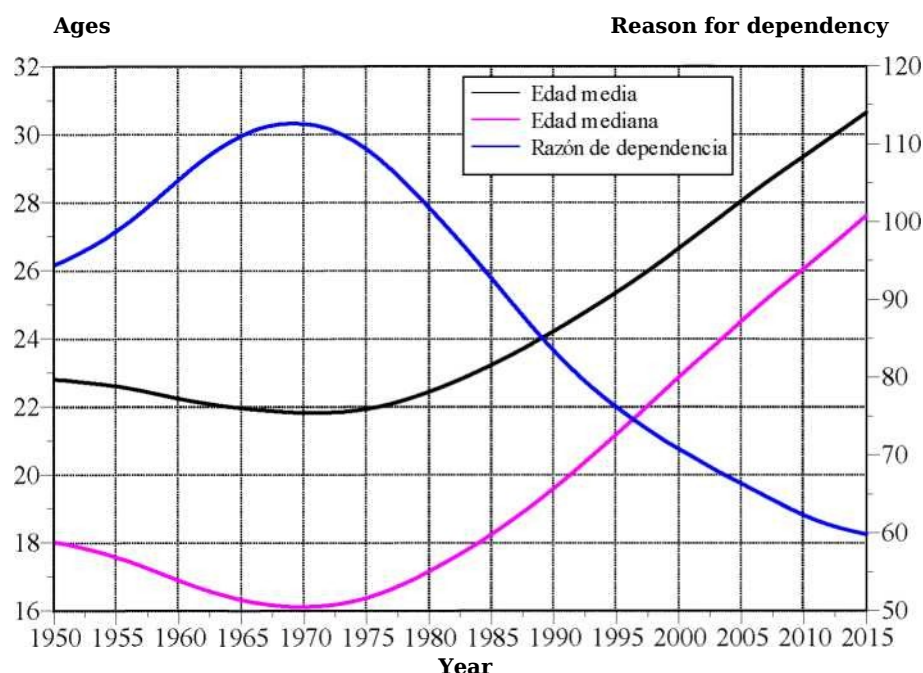
Source: Estimates based on chapters 2, 3 and 4.

Figure 5.7. Components of population growth, 1950-2015



Source: Estimates based on chapters 2, 3 and 4.

Figure 5.8. Mean and median ages and demographic dependency ratio, 1950-2015



Source: Estimates based on chapters 2, 3 and 4.

The time series of births and deaths, along with their associated crude rates, is shown in Figure 5.5. While the effect of birth control, as a reduction in the number of births, was delayed for more than twenty years, the progressive decline in offspring is evident in the notable slowdown in birth growth once family planning took hold. Meanwhile, the increase in the crude death rate during this century is largely due to the aging of the population's age structure, but also to a general increase in mortality, reflected in the progressive rise in the number of deaths.

Figure 5.6 contains the final estimates of international migration from Mexico from 1950 to 2015. The recent shift in trends is evident, with a marked decline in emigration and a surge in immigration from 2000 to 2010, a scenario presumed to be linked to the severe economic crisis that has plagued the United States since 2008. A similar situation was observed in the 1930s, when a similar economic crisis occurred in the United States, and the Mexican-born population residing in the U.S. contracted by almost 40%, falling from 641,000 in 1930 to 374,000 in 1940. Signs of the incipient economic recovery in the U.S. appear to be linked to the recent increase in emigration and the decline in immigration, which is seen as a less viable option for Mexicans returning to Mexico.

The sum of natural growth (excess of births over deaths) and the ere-

The social foundation (immigrants minus emigrants) leads to population growth. Its temporal trajectory is shown in Figure 5.7. The parsimonious decline of natural growth is altered by changes in net migration, mainly due to the behavior of emigration to the United States.

The changes in the age structure of the population, outlined in Figure 5.3 for selected years, can also be succinctly illustrated by three indicators summarized for the six and a half decades considered: the mean age of the population, the median age, and the demographic dependency ratio (population under 15 years of age and 60 years of age or older per 100 people aged 15 to 59). All three measures are reproduced in Figure 5.8. The recovery of the mean and median ages is a clear indication of the gradual aging of Mexico's population since the early 1970s, when half the population was under 18 years of age. The reversal in the trend of the dependency ratio, meanwhile, reflects the rapid growth of the working-age population (15 to 59 years), giving rise to the so-called demographic dividend. Projections carried out using the base population used in this study will account for the closing of this potential window of opportunity.

Part II. The State Population

6 Population of the states 1970–2015

Undoubtedly, the analytical richness of demographic estimates increases as the level of geographic aggregation decreases. Knowledge of past trends in population size and mortality, fertility, and migration in more specific territorial areas, in addition to providing a long-term perspective, constitutes an essential piece of information for developing population projections at subnational levels.

Determining population by state, using single-age data and on an annual basis, is a more complex task than for the country as a whole because, in addition to mortality, fertility, and international migration, interstate migration is also a factor. Furthermore, it is essential that the sum of the estimated populations and events (deaths, births, and international migrants) for the 32 states matches the previously obtained national totals.

A simultaneous retrospective count for all 32 states, similar to the national count in Chapter 5, can be conducted while maintaining the condition that the totals satisfy the national totals. However, it faces the dilemma that, in some states, the estimated population might be lower than that listed in the census, count, or intercensal survey. If this were the case—and it actually occurred in an initial attempt at the demographic reconciliation under discussion—the retrospective figures would need to be adjusted to uphold the principle that a state's census, count, or survey cannot have *excess* population (except in 1980, as discussed in section 5.1).

One alternative—which we pursued in that initial attempt—is to retain the total census population from a certain age (for example, 3 years) in those states where the census count exceeds the retrospective count, and then prorate the remaining national total, previously obtained, among the other states, following the territorial distribution of the retrospective count. Proceeding in this way presents another dilemma: the trends in mortality, fertility, and interstate and international migration no longer account for the population growth implicit in the new populations, since we are modifying the initial populations (those from the retrospective count).

To avoid cumbersome adjustments for reconciling populations and demographic variables, we assumed that the omission percentages for the national population aged 3 and over (estimated in Chapter 5 for the 1970–2010 censuses, the 1995 and 2005 counts, and the 2015 intercensal survey) are the same for all states. This ensures that no state is overcounted (except in 1980), minimizes the distortion of demographic trends, and satisfies the principle of the balancing equation or demographic balance.

It seeks the reconciliation of populations with demographic variables.

The remaining part of this chapter describes how the state populations were estimated.

Before moving on to present the estimate of the state population, it is convenient to establish two "closure" principles that will govern the estimates in this chapter and the following three, which are dedicated to demographic variables.

Let $P_x(t)$ denote the population of age x residing in state i at time t . If $P_x(t)$ is the national population, it must be guaranteed that:

$$\sum_{i=1}^{32} P_x(t) = P_x(t) \quad \text{for } 0 < x < 109 \quad (6.1)$$

Likewise, if $E_x(t)$ are the events (births of parents, deaths or migrations) of age x that occurred in state i during the year beginning in t and $E_x(t)$ are the nationals, it is expected that:

$$\sum_{i=1}^{32} E_x(t) = E_x(t) \quad \text{for } 0 < x < 109 \quad (6.2)$$

In this chapter and the following three, the aim is to ensure that population and event estimates satisfy both "closure" principles.

6.1 Correction of the listed populations

In section 2.2.2, it was stated that the different census undercounting of children compared to the rest of the population in Mexico only occurs during the first three years of life. If this observation is extended to the federal entities, the first step in obtaining state populations is to overlay the state distribution of individuals aged 3 years or older from each census between 1970 and 2010, the 1995 and 2005 counts, and the 2015 survey onto the national totals estimated in Chapter 5. This satisfies the assumption of equal undercounting in all 32 states. The results are presented in Table 6.1.

The next step is to estimate the populations by age distribution. To do this, we use the iterative biproportional allocation algorithm (see Appendix A), the application of which requires known row and column marginals, and an initial array that is representative of the data to be estimated.

For each population enumeration and sex separately, let's assign age to the rows and the columns to the states. Clearly, the row marginals are the national population by age group obtained in Chapter 5 for the specific census date, and the column marginals are the populations aged 3 and older, estimated as described above (Table 6.1). The initial arrangement is the state populations, smoothed using Gray's proposal including cohort effects—as described in Section 2.2.2.

Once the populations aged 3 years and older by age group have been obtained, the next step is to estimate the number of children aged 0 to 2 years. Assuming that coverage is equal in all federal entities may not be appropriate, as it is conjectured

State	1970	1980	1990	1995	2000	2005	2010	2015
<i>Men</i>								
Mexican Republic	22 087 582	30 188 248	37 870 462	41 988 285	44 836 253	48 483 767	52 204 314	55 820 605
Aguascalientes	152,586	230 560	330 555	390 537	428 662	493 771	545 773	611 419
Baja California	398 042	537 023	793 724	990 074	1,163,520	1,371,825	1,513,842	1,587 605
Baja California Sur	60 214	99 694	154 334	178,915	205,487	251 401	306 488	343 849
Campeche	117 187	191 284	254 907	300 554	325 757	362 757	388 757	424 053
Coahuila	518 106	708 673	933 576	1,011,485	1,076,422	1,197,422	1,299,222	1,401,730
Colima	111 178	157,558	202 288	227,779	250,975	270 954	306 403	335 964
Chiapas	732 252	966 997	1 503 018	1,654,047	1 802 075	200747	2,208,904	2,398,401
Chihuahua	743 965	917 683	1,155,741	1 301 031	1,427,020	1,549,722	1,616,404	1,692,201
Mexico City	3 061 069	3 884 388	3,767,501	3 871 604	3 918 137	4,078,866	4 103 951	4159 110
Durango	436 154	538 508	628 309	662 780	667 166	712 307	763 507	821 508
Guanajuato	1,041,530	1,354,220	1,816,110	1 986 070	2,090,620	2,239,776	2,492,171	2,697,930
Warrior	732 082	960 018	1 210 350	1 327 100	1,393,120	1,441,756	1,551,721	1,615,730
Gentleman	550 697	707 404	881 475	974 814	1 024 224	1,088,622	1 215 115	1,313,374
Jalisco	1,490,041	1,947,463	2 433 056	2 731 089	2 862 000	3,154,620	3,424,923	3,682,215
Mexico	1,760,945	3,395,930	4 603 492	5 401 871	6 026 673	6,567,917	7 053 516	7 570 315
Michoacán	1,070,506	1,297,691	1,626,573	1,760,606	1,797,604	1,828,500	1,988,470	2 105 224
Morelos	282,969	427 651	556 681	659 098	705 065	747 051	818 167	880 230
Nayarit	253 047	332 162	389,600	420 096	431 312	454,990	511 205	558 079
Nuevo León	780 252	1,142,725	1,479,793	1,670,388	1 806 603	2,026,844	2 219 175	2,450,416
Oaxaca	923 872	1,085,111	1,396,143	1,478,079	1,563,806	1,620,244	1,724,517	1 807 16
Puebla	1,148,368	1 502 102	1 900 900	2 101 018	2,295,906	2,475,873	2,629,205	2 822 331
Querétaro	222 165	332 784	487 329	571 580	640 655	741 572	839 839	951 680
Quintana Roo	41,890	105 221	241 515	332 648	422 622	539 602	634 604	719 241
San Luis Potosí	592,923	759,955	931 083	1 011 712	1,054,561	1,127,021	1,198,676	1,266,900
Sinaloa	591 410	848 492	1,047,525	1,139,317	1,194,140	1,253,762	1,317,023	1,413,610
Sonora	508 230	696 841	873 317	983 028	1,049,620	1,159,615	1,273,515	1,354,212
Tabasco	355 488	486 514	708 880	813 571	883 300	945 400	1,040,140	1,118,240
Tamaulipas	665 715	871 209	1,060,644	1,176,469	1,285,805	1,441,970	1,540,104	1,628,702
Tlaxcala	196 194	253 531	356 268	406 240	444 111	497 322	537 400	590 380
Veracruz	1,764,532	2 452 061	2 918 248	3,117,942	3 177 079	3,329,900	3,533,153	3,769,050
Yucatán	353 404	487 229	640 281	724 029	776 622	869 126	922 424	992 969
Zacatecas	430 569	509 566	587 237	612714	614 310	636 500	686 500	734 975

State	1970	1980	1990	1995	2000	2005	2010	2015
<i>Women</i>								
Mexican Republic	22 159 056	30 552 002	38 856 035	43 350 063	46 624 100	50 848 024	54 724 020	58 445 040
Aguascalientes	156 055	237,346	345 722	408 513	454 013	524 148	575 641	635 548
Baja California	400 235	545 847	780 706	973 425	1,131,381	1,337,720	1,481,530	1,582 160
Baja California Sur	57,084	94 648	146,485	172,512	194,616	238 010	291 581	330 922
Campeche	115 290	188,804	249,387	297 144	323 852	366 606	395 044	434,994
Coahuila	506 387	708 114	935 891	1,023,713	1,082,131	1,207,520	1,315,470	1,411,300
Colima	109,787	157 122	202 951	230 488	254,772	276 412	310 838	342 067
Chiapas	712 618	933 211	1,484,994	1,658,615	1,823,525	2,068,355	2,294,825	2,505,800
Chihuahua	732 198	926 314	1,157,154	1 310 853	1,423,755	1,556,306	1,633,405	1,718,266
Mexico City	3 296 249	4,188,792	4,077,708	4 208 018	4 252 000	4,431,770	4,482,600	4,558,761
Durango	418 625	534 105	639 613	676 204	689 126	739 260	787 942	845 853
Guanajuato	1,032,746	1,372,631	1,922,317	2 114 916	2,262,477	2,457,160	2 694 000	2 861 000
Warrior	734 290	957 771	1,251,197	1,377,373	1,473,180	1,545,580	1,649,701	1,730,711
Gentleman	545 659	694 063	899 316	1 002 241	1,083,400	1,174,760	1,308,250	1,413,730
Jalisco	1,522,652	2,026,026	2,574,913	2,876,517	3,039,286	3,323,951	3 570 014	3 805 150
Mexico	1,728,539	3,401,596	4,692,651	5,556,798	6 248 000	6 860 010	7 415 000	7 971 000
Michoacán	1,060,811	1,321,981	1 716 074	1 863 029	1,938,720	1,996,820	2 135 000	2,245,370
Morelos	284 121	432 839	577 850	689 610	752 059	805 829	877 545	942 262
Nayarit	244 460	325 150	387 392	419 901	434 374	462 096	513 843	560 398
Nuevo León	771 543	1,139,239	1,474,554	1,673,942	1 803 066	2,026,532	2 225 130	2,453,900
Oaxaca	938 958	1,087,221	1 442 040	1,541,499	1,668,290	1,764,250	1,883,380	1 971 000
Puebla	1,162,296	1,532,984	1,984,943	2,216,561	2 452 070	2 683 000	2,862,890	3,060,400
Querétaro	220 321	331 276	499,957	590 891	676 151	787 729	890 094	988 080
Quintana Roo	38 244	97 048	222 051	313 609	396,889	516 140	612 080	706 293
San Luis Potosí	579,724	755 004	948 294	1,036,968	1,099,170	1,192,130	1,261,680	1 333 000
Sinaloa	565 091	823 144	1,035,293	1,133,413	1,189,160	1,262,407	1 329 000	1,432,400
Sonora	502 112	680 309	856 228	971 045	1,033,595	1,146,670	1,255,240	1,364,765
Tabasco	343 977	473 287	701 911	817 499	895 868	971 453	1,075,195	1,155,638
Tamaulipas	669 856	884 102	1,074,266	1,195,227	1,304,830	1,466,160	1,573,170	1,662,900
Tlaxcala	189,715	251 900	363 085	419 645	462 042	527 042	573 724	625 402
Veracruz	1,737,751	2,447,490	2,955,649	3 207 207	3,338,150	3,564,790	3,778,370	4 010 000
Yucatán	352 666	485 654	647 119	734 058	789 194	886 661	947 875	1,020,700
Zacatecas	428,996	517 074	609 227	638 629	653 426	680 474	723 433	763 873

Source: Chapter 5, population censuses from 1970 to 2010, population counts of 1995 and 2005 and intercensal survey 2015.

The omission of children under 3 years of age is due to the idiosyncrasies of specific populations, rather than to confusing situations of habitual residence, presumably those that determine the omission of people aged 3 years or older.

Let's consider children under one year of age. These children are the offspring of births in the immediately preceding year, survive mortality, and move geographically according to prevailing internal and international migration patterns (see Equation 5.1). Statistically, internal and international migration are infrequent events; and, as a complement to mortality, the difference in survival probabilities in the first year of life between states is small. Thus, one would expect a strong association between the state distribution of births in the previous year and the number of children under one year of age at the time of the census.

Furthermore, there is a close link between internal and international migration rates in the early years of life, since almost all children move spatially with their parents within a family migration pattern.

Based on these arguments, a close relationship is expected between the territorial distribution of births and the 3-year-old population, the youngest for which we have the results of the iterative biproportional allocation.

Before examining the accuracy of our conjecture, we need the state distribution of births. The iterative biproportional allocation method provides us with women of childbearing age, thus requiring only age-specific rates to determine the total number of births. The following chapter describes the selection of state fertility levels and their adaptation to the national level for each year of the 1970–2015 period. Using a similar procedure, we obtained the state fertility rates associated with census dates. Deducing the number of births around the census date is straightforward, as is their territorial distribution.

The eight panels in Figure 6.1 corroborate our conjecture; even the linear correlation coefficients are quite high. The marked association between both distributions allows us to derive the state distribution of ^{children} aged 0 to 2 years from the territorial allocations of births and 3-year-olds.

Let $q(x, t)$ **denote** the proportion of the national population of exact age x living in state i at time t (the census, count, or survey date). Since birth is exact age zero, let's link completed age zero to 0.5, one to 1.5, two to 2.5, and three to 3.5. We know the values of $c(0, 1, 1)$ and $c(3.5, 1, 1)$, and, given the proximity of these values for the 32 states, we can linearly interpolate between these proportions to determine the corresponding proportions for completed ages 0-2:

$$C_i(x + 0.5, t) = q(0, i) + \sum_{a=0.1, 2}^r [q(3.5, t) - C_i(0, t)] \quad (6.3)$$

Since, for any age, the sum over the 32 states must equal one, the linear equation satisfies that principle. Indeed:

¹ From 0.995 or more from 1995 to 2015, 0.980 in 1970, 0.988 in 1980 and 0.992 in 1990.

Figure 6.1. Relationship between state distributions of births and the 3-year-old population, 1970-2015

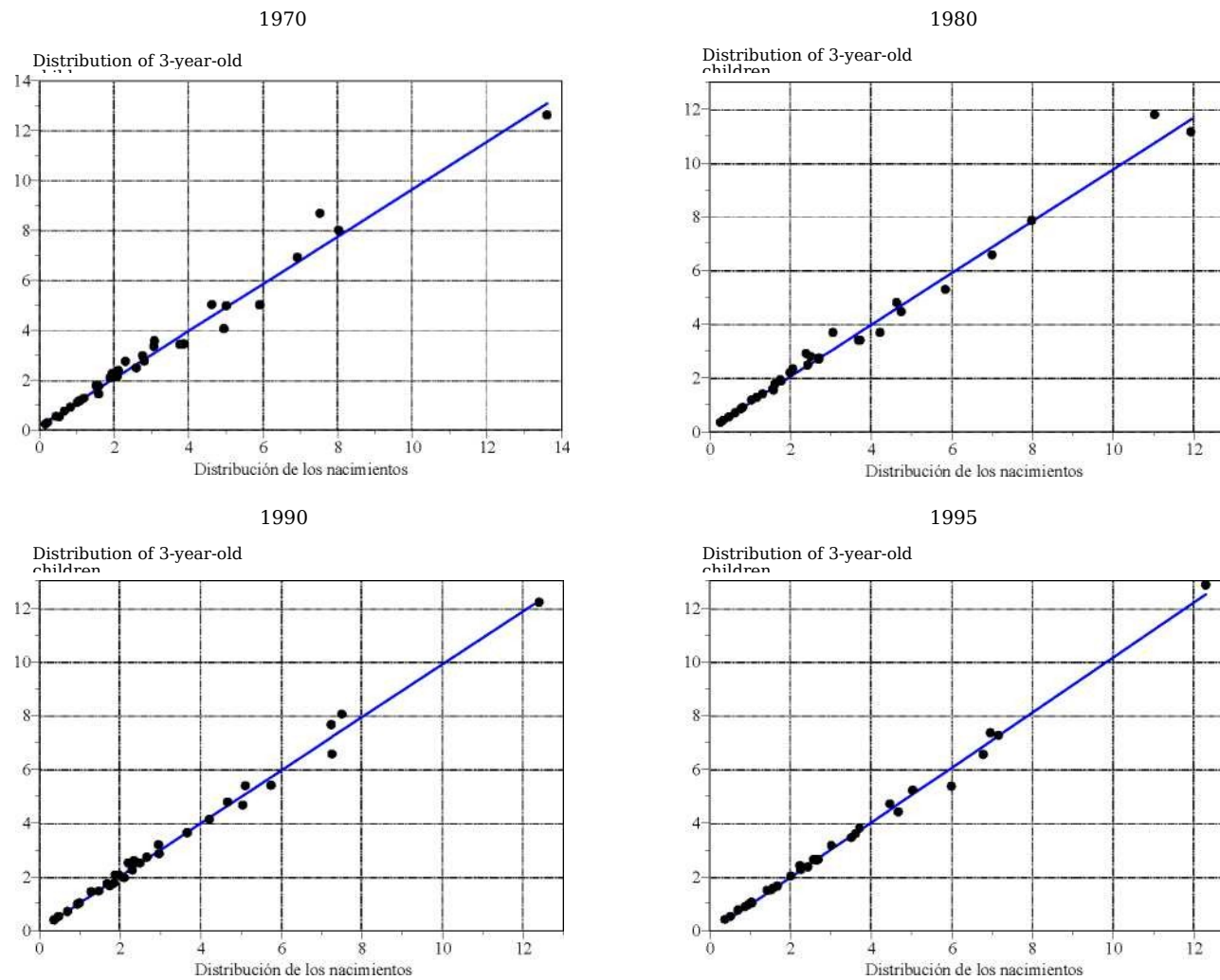
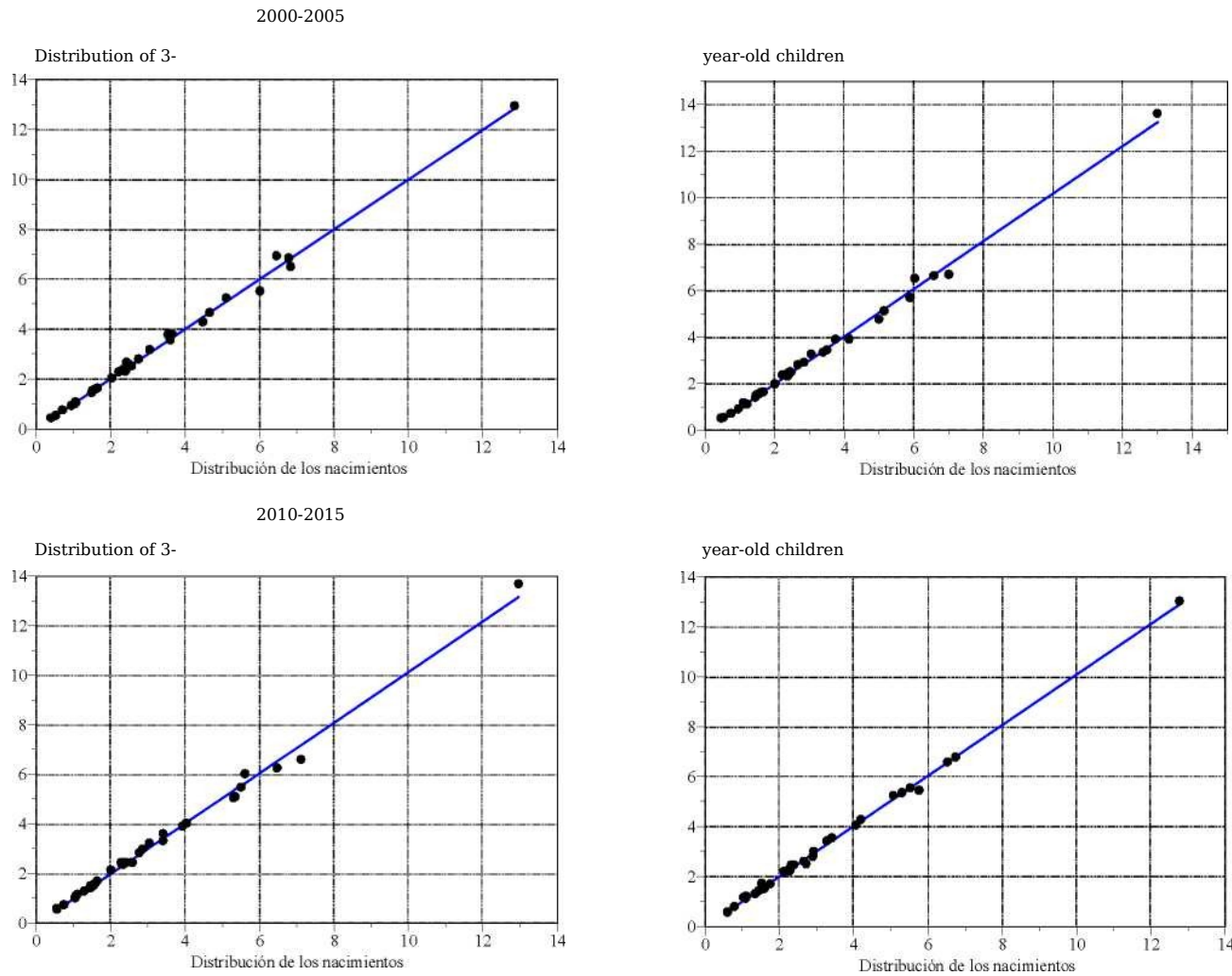


Figure 6.1.
(Concludes)



Source: Population censuses and counts and intercensal survey from 1970 to 2015.

$$\hat{c}_i(x, t) = \sum_{i=1}^{32} c_i(x, t) = \sum_{i=1}^{32} \left(\hat{c}_i(x, t) + \sum_{j=1}^{32} \hat{c}_j(x, t) \right) = 1 + \kappa \quad \text{for } [1 - 1] = 1$$

By overlaying the state distribution onto the national populations of children aged 0, 1, and 2 years, the number of children of those ages per state is obtained. It was assumed that the sex ratio of 104 at birth—adopted for the entire country in Chapter 5—was the same for all states, thus implying that the distribution of births is equal for both sexes.

In all three age groups, across the five censuses, both counts, and the survey, population enumerations were underestimated in all states, except in a few cases where the enumerated populations were larger than the estimated populations. Although the differences are not large, we prefer to retain the enumerated populations in these cases, as over-enumeration in the censuses, counts, or survey is not permissible. The sum of these cases was subtracted from the national total, and the remainder was distributed among the other states according to the state distribution resulting from superimposing the result of (6.3) onto the national total. The final population aged 0 to 2 years in the censuses and counts is presented in Table 6.2.

6.2 The population at the beginning of each year

The estimate of residents in each federal entity, by age and sex, as of January 1 of each year of the period 1970-2015 was obtained in five steps:

1. For each state, an initial population estimate was obtained through geometric interpolation, except for 1970 and 2016, which were extrapolated based on growth from 1970 to 1980 and from 2010 to 2015, respectively. For the period 2000-2010, the decade's growth was omitted to avoid skewing the temporal behavior due to methodological differences between the 2005 count and the 2000 and 2010 censuses, as mentioned in section 2.2.3. The resulting state distribution was then superimposed on the national totals estimated in Chapter 5 for each year.
2. For each calendar year, annual exponential growth rates were calculated, and their time trend was smoothed using the robust **lowess procedure of the STATA** software package (2003), with a window of 25% of the observations. The sum of the rates for each of the decades considered was provided, such that the total population estimates for 1970, 1980, 1990, 2000, 2010, and 2016 from the previous step were maintained. Intermediate state distributions were overlaid on the national totals estimated in Chapter 5.
3. The state distribution resulting from the population estimate at census dates was linearly interpolated with respect to time for each single age separately:

$$C_i(x, t_0 + y) = C_i(x, t_0) + \frac{(t - t_0)}{(t_i - t_0)} [C_i(x, t_i) - C_i(x, t_0)] \quad \text{for } t_0 < t < t_i \quad (6.4)$$

State	1970	1980	1990	1995	2000	2005	2010	2015
<i>Men</i>								
Mexican Republic	2,974,909	3,390,285	3,531,919	3,563,599	3,487,869	3,436,819	3,421,853	3,390,111
Aguascalientes	21,069	27,508	33 308	36,646	37,333	39,160	38,959	39 401
Baja California	49,170	51 604	71,066	82,398	87,925	93 620	94 765	90 035
Baja California Sur	7336	10,185	12,942	13,821	14,479	16,428	18,967	20,341
Campeche	15,463	22,410	24,894	25,866	25,398	25,089	25,166	26,723
Coahuila	66 033	74,544	79 107	82 239	81,938	84,696	85 843	89,543
Colima	14419	17,335	17,493	18,331	18410	17,913	18,979	20,434
Chiapas	107,353	120 315	169,537	166 041	164,706	168,749	177,418	191,065
Chihuahua	95 328	93 468	102 039	109,450	107,906	108,549	106,604	100 100
Mexico City	385 701	388 418	272 271	252 894	230 522	214 162	199,315	173,752
Durango	59,958	62,480	62,520	59 602	55 331	53,690	52,693	54,543
Guanajuato	144 284	160,604	183,943	182 017	180,506	177 186	178,731	178,349
Warrior Gentleman	109 042	121 119	129,562	129 260	127,826	116,629	115 214	113,431
	75,679	83 130	83,713	85 283	82,996	79,879	82,613	81,974
Jalisco	205 256	228 717	244 138	236 811	231 522	235 157	234 225	228 434
Mexico	241 826	386 390	432 951	447 365	525 525	454 862	455 557	434 845
Michoacán	150,693	157,566	170,749	162,552	152,589	138,479	137,746	143 061
Morelos	36,450	45,867	47,840	55 132	54 123	50,793	50,915	51,297
Nayarit	33 217	37,573	35,409	34 304	33 057	31,917	34,778	36 253
Nuevo León	97 345	113 292	107,419	122,943	124,536	132,761	134 015	137,882
Oaxaca	133,575	133 852	149,482	136 252	132 109	120,415	119,984	117,853
Puebla	162,993	188 212	198 276	202 134	201 852	198 154	189 225	187,637
Querétaro	31,530	41,349	51,421	51,740	53,320	54,929	56,486	59,416
Quintana Roo	5,483	12,200	24,878	31 303	35 207	39,263	42,860	44 226
San Luis Potosí	82,491	91 003	94 123	93 726	88 879	85 310	80 817	76,620
Sinaloa	75 248	90 262	86,991	92 142	88 572	82,582	80 536	80,759
Sonora	63 191	70,998	71 174	79,696	77 807	79,098	79,732	77,945
Tabasco	49,792	57,604	69,971	71 609	70 218	68 092	70,296	73 135
Tamaulipas	84 305	89,657	87 237	93 697	95 941	98 618	99 007	98 119
Tlaxcala	25,924	29,386	34 360	36,531	36,659	37,932	37,533	37 222
Veracruz	237,472	268 026	263,384	258 556	238 222	226,799	218,739	222 127
Yucatán	44,957	52715	60,478	59003	57,345	57 034	54 501	53,896
Zacatecas	62,326	62,496	59 243	54 255	51 152	48,835	49 152	49,703

State	1970	1980	1990	1995	2000	2005	2010	2015
<i>Women</i>								
Mexican Republic	2,897,150	3,295,660	3,420,412	3,443,367	3,359,227	3,315,000	3 306 243	3,274,657
Aguascalientes	20,535	26,565	32 119	35,469	35,974	37,630	37,353	37,483
Baja California	48 282	50 251	66,734	79 332	84 176	90 214	91 225	88 583
Baja California Sur	7 172	9898	12,485	13,311	13,845	15,806	18,372	19,615
Campeche	15 272	21,950	24,096	24,946	24,603	24,252	24 142	26,176
Coahuila	63,397	72,560	76,790	79 146	78 789	81,595	83 072	85919
Colima	14013	16,741	16,897	17,508	17,483	17 233	18,278	19,335
Chiapas	104 403	117,521	164 165	161,891	159 213	163,720	172,256	186,487
Chihuahua	92 049	90 543	96 837	105 431	103 682	104 060	103 070	98 257
Mexico City	376 252	376 183	256,765	243 237	221 222	206 260	192,084	168,951
Durango	57,317	60,590	60,867	57,626	53 127	51,558	51 018	52,724
Guanajuato	139,949	156 501	178,478	176,774	173,952	171,380	172,916	171 155
Warrior	106 021	117,930	126,989	124,766	123 672	113 226	111,732	109 264
Gentleman	74 803	80 685	82,900	82 813	79,823	77,094	79,783	78,746
Jalisco	200 536	221 898	235 533	228 363	222 440	226 518	226 070	220 220
Mexico	234 985	377 130	419 443	432,977	433 445	438 551	441 300	415,980
Michoacán	145,866	153 114	166 138	157 256	147 122	134 020	133,345	138 272
Morelos	35,781	44,519	46,260	53 003	52,384	48,923	48,881	49 211
Nayarit	32,428	36,259	34,467	33 119	31,666	30,874	33,325	34,983
Nuevo León	93 469	108,775	104,550	118411	119,340	128 022	129,452	134,430
Oaxaca	132,459	130,847	146,826	132,350	127,880	116 022	116 116	114 061
Puebla	159 232	184,296	194,600	195,981	195 142	191,450	182,954	181,911
Querétaro	30,738	40 250	49,782	50,514	51,439	52 844	54,621	56,664
Quintana Roo	5,464	11,752	23,541	30 311	33,987	38 107	41,589	43 245
San Luis Potosí	80 101	88,599	91 253	90 275	85 873	82,494	78 008	74 136
Sinaloa	72 709	87 126	85,586	88 864	85 109	79,655	77 511	77 306
Sonora	62 801	68 708	68 800	76,512	74,512	75,744	76,650	76 891
Tabasco	48 226	56 152	68 868	69,476	67,929	65,488	67 705	69,513
Tamaulipas	83 538	86 712	83,740	89,975	91 955	95 263	95 515	95 237
Tlaxcala	24,792	28,604	33,663	35 172	35,398	36,578	36 172	35,756
Veracruz	228 721	260 861	255,958	249 256	229,945	218 560	211 204	213 055
Yucatán	44,608	51,360	57,971	57 151	55 001	55 027	53 137	52 831
Zacatecas	61 231	60,789	57,312	52 151	49,180	47,089	47,528	48 142

to locate it on January 1 of each year of the period 1970-2015 (t), where t_0 is the date of a population enumeration and t_i of the next one.

4. The state distribution, for each age, sex and year, was superimposed on the corresponding national total.
5. Taking the national population by single ages as row marginals, the total state populations, obtained in step 2, as column marginals, and the inhabitants from step 4 as the initial arrangement, the final population was obtained by iterative biproportional allocation.

The four steps were performed for each sex separately. It is clear that the sum of the state distribution, calculated with (6.4), is also equal to one.

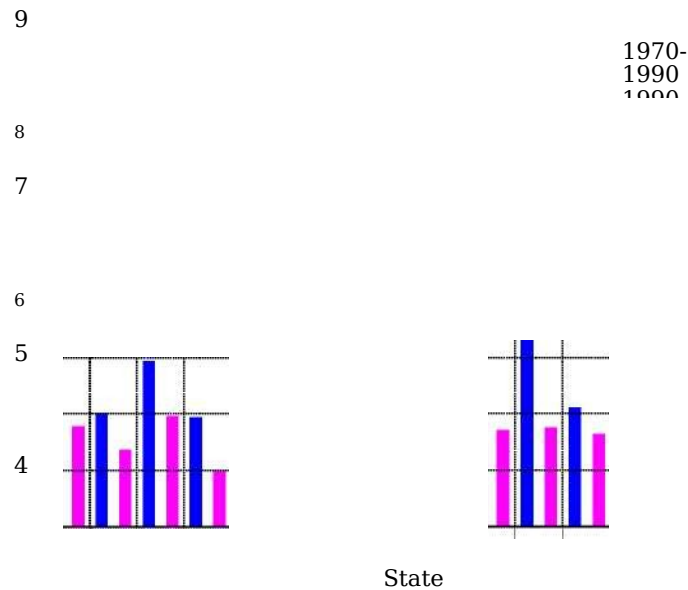
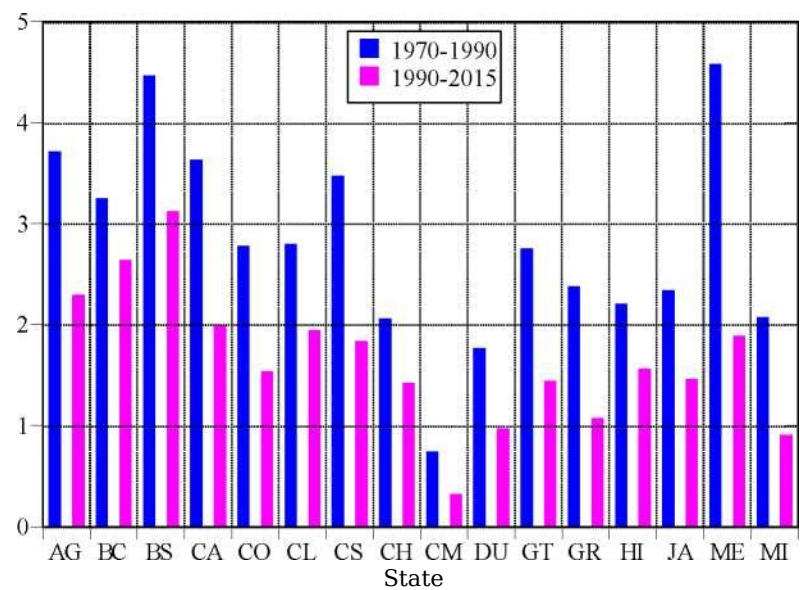
This procedure was chosen to obtain a parsimonious trend in the total population, by age and sex. The mid-year population was obtained as the arithmetic mean of the inhabitants at the beginning and end of the year. The national total was obtained by summing the populations of all 32 states.

Population growth rates for the four and a half decades covered by our demographic reconciliation horizon generally show a decline in the most recent five-year periods, as shown in Figure 6.2. Quintana Roo stands out for its relatively high population growth in both periods. While significantly lower, Baja California Sur's rates are still higher than those of the other thirty states, demonstrating that tourism is one of the most dynamic economic sectors. The high rate in the State of Mexico between 1970 and 1990 reflects the intense migration from Mexico City to its neighboring state within the Mexico City metropolitan area. The marked reduction in the State of Mexico's rate during the second period indicates that the intensity of intra-metropolitan mobility has decreased considerably.

Figure 6.3 shows the evolution of the growth rate for four states, which exhibit dissimilar patterns and presumably represent state-level diversity. The increase in the growth rate of Baja California Sur has been continuous in the new century, recovering the level reached in the 1970-1990 period; in contrast, the decline in Quintana Roo is evident and does not appear likely to rebound in the future, as it is close to ceding its leading position to Baja California Sur. The aforementioned decrease in residential mobility within the Mexico City metropolitan area is evident in the marked decline in population growth in the State of Mexico. In Chiapas, the increase in the rate during the 1980s was due, on the one hand, to the fact that it was one of the states where contraceptive use was postponed the longest and, on the other hand, to the fact that it was one of the states that benefited most from the expansion of health services.

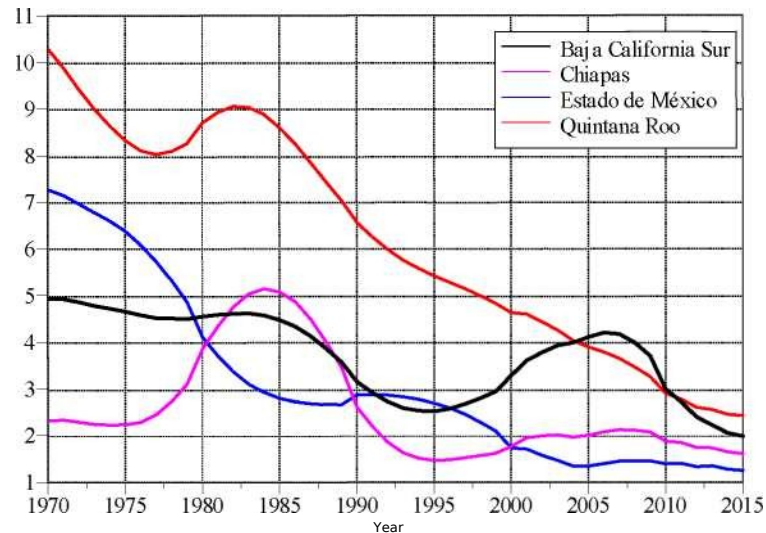
Since the 1970s, trends in fertility, mortality, and interstate and international migration have shaped increasingly aging age structures. This process is evident in the four age compositions shown in Figure 6.4, which again aim to summarize the wide range of age structures—and their changes over time—across the 32 states.

Chart 6.2. Average annual growth rates
by state, 1970-2015
(Percent)



Source: Estimates based on censuses, counts and intercensal survey, 1970-2015.

Figure 6.3. Annual population growth rates for four selected states, 1970-2015 (Percent)



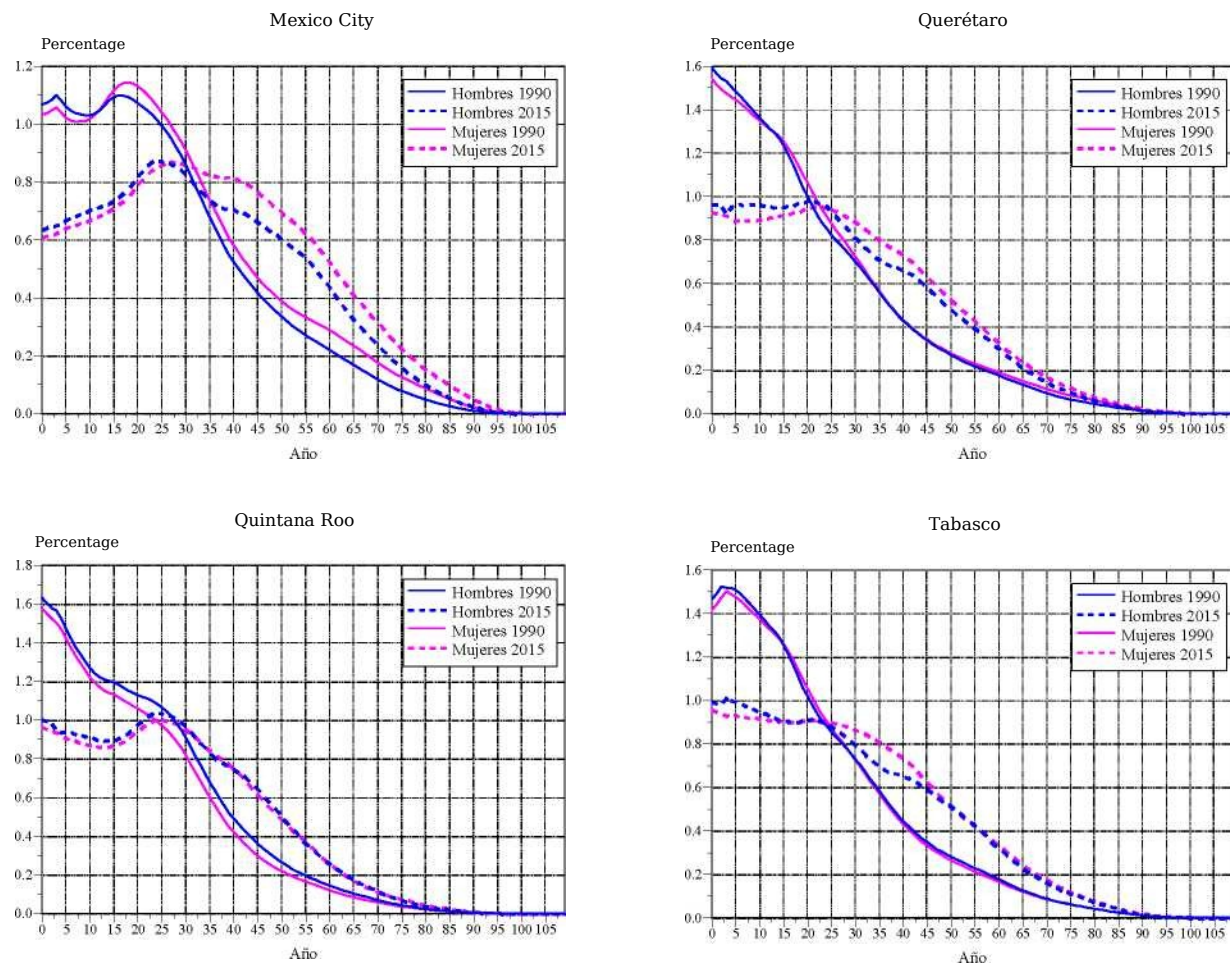
Source: Estimates based on censuses, counts and intercensal surveys, 1970-2015.

In the four selected states, a clear decrease in the participation of children and adolescents is observed, stemming from the decline in fertility—as we will see in the following chapter. However, this is also a consequence of the higher rates of biological reproduction among couples, resulting in the highest concentration of those under 25 years of age in Tabasco in 2015 compared to the other three states.

The clear increase in the 15-35 age group in Quintana Roo is an unequivocal sign of the intense immigration to the state, whose age pattern we reviewed in chapter 9.

In summary, the population censuses from 1970 to 2015, the two counts and the intercensal survey reveal, in general, a gradual decline in the rate of growth, reversed in the country and some states by the abrupt change in the components of international migration, but without substantially stopping the continuous process of aging of the age structure, originating in the joint decline of fertility (fewer children) and mortality (greater chances of reaching old age).

Figure 6.4. Age structures of four states, 1990-2015



Source: Estimates based on censuses and population counts and intercensal surveys from 1970 to 2015.

7 State fertility

The objective of this chapter is to obtain plausible estimates of fertility rates in the states. These estimates are derived from vital statistics, population censuses, pregnancy histories from surveys, and birth certificates for recent years. Each data source has strengths and limitations that have varied over time. Although the overall trend in data quality is toward improvement, even in recent years there are still some discrepancies regarding the precise level of fertility in the country as a whole. When we look at the state level, the limitations are greater, due, among other reasons, to the lower representativeness of the surveys and the mobility of the population between states.

As with the national data, we analyzed vital statistics by year of birth and registration, allowing us to track birth cohorts up to four years after they occurred; in this case, all children were under five years of age at the time of registration. We also reconstructed birth cohorts for those registered up to seven years after they occurred, that is, children registered before their eighth birthday. These estimates allow us to identify the states where late registration is most prevalent, particularly for the earliest years. Unlike the national analysis, where fertility was used to estimate the population by age and sex year by year, the state population, estimated in Chapter 6, will now be the denominator for all rates.

Sample surveys using pregnancy history data have been very useful for understanding various aspects of fertility in our country. This source has the advantage of providing both the numerator and denominator of the rates. However, at the state level, the sample size is considerably reduced, so that sometimes the estimates have very wide confidence intervals, making them inadequate from a demographic perspective. For statistically simple indices—including the total fertility rate (**TFR**)—the sample sizes of the National Survey of Demographic Dynamics (**ENADID**) are sufficient to obtain accurate estimates for each state. However, age-specific fertility rates are indicators for which the sample size is insufficient in some cases, as will be discussed later.

Another element of the surveys that we take into account to evaluate the estimates is the level of contraceptive use and its variation over time, for which we use the proportion of women in unions of reproductive age (15 to 49 years) who use contraceptive methods in the ENADID surveys of 1992, 1997, 2006, 2009 and 2014.

From census information, we analyzed estimates of the total fertility rate (TFR) in 1999, 2009-2010 and 2014, obtained from information on the date

The date of birth of the last live birth in the 2000 and 2010 population censuses and the 2015 intercensal survey were used. In addition, to obtain other estimates of fertility levels in the federal entities, we used the average parity rates for women aged 30 to 34 in the censuses and the intercensal survey. These latter rates serve as a reference, since they are obtained from relatively easy-to-collect and well-reported information. These parity values should always be lower than the total fertility rates, especially when the overall fertility level is high and the fertility rate of women over 30 is substantial.

Since 2008, birth certificate data has been available for estimating fertility. Due to its universal nature, like vital statistics, it is a suitable source for estimates at the state level. However, as shown in the following paragraphs, its coverage is still not complete in rural and more isolated areas of the country, so the omission primarily affects states where access to medical services is more limited and where the implementation of the birth certificate has not been widespread.

Finally, we incorporated the state fertility levels for the period 1970-1990 estimated by Mier y Terán and Partida (2001).

7.1 Vital statistics

The greatest strengths of vital statistics are that there are no major distortions in the timing of births, the data are provided by the parents themselves, they are population-level data, and they are a continuous source. Conversely, the most significant limitations are late registration, multiple registration, and omission.

Alternative sources of information indicate that the omission is not significant, given the increasing institutionalization of Mexican life, primarily through educational, health, labor, and social programs. The results of the 2015 Intercensal Survey show that only 1 to 2% of the population aged 6 and over is unregistered; among children under 6, the proportion is slightly higher, close to 6%, and consists of children who will mostly be registered before starting school.

To limit the distortions caused by the other two limitations, we tracked cohorts registered up to four years after they occurred. This timeframe covers a large proportion of births and, at the same time, minimizes multiple registrations. This cohort reconstruction procedure presents the problem of incomplete data for recent years. In our case, the last cohort observed in its entirety is that born in 2011, as births are only available up to four years later, in 2015. To address this limitation, for the most recent cohorts, we assumed that the proportion of births registered between two successive ages remained constant from year to year, thus completing the registration of births from 2012 onward.

When cohorts of births registered up to four years after the year of birth are reconstructed, it is observed that the temporality of the registration

This varies substantially among the federal entities. In some, more than 97% of births are registered in the same year they occur or the following year, while in others, registration in the same year and the following year is less common. To avoid distortions due to variation in late registration, we also followed cohorts for up to seven years after they occurred. In this case, there is a greater possibility of duplicate registration, which is difficult to distinguish from late registration, and the truncation affects a larger number of cohorts, since the last cohort observed in its entirety is the one born in 2008.¹

Based on births resulting from cohort follow-up, Table 7.1 presents the total fertility rates for each of the federal entities for six selected years. In 1990, the TFR values, when considering registration up to age 4, varied considerably between 2.7 in Mexico City and 4.6 in Oaxaca; a value very close to the latter was observed in Puebla and Guerrero (4.4). In the following years, the decline was widespread, although at different rates. In 2000, the rates had decreased by slightly more than half a child. Mexico City had a rate below the replacement level (2.1), while in Guerrero and Chiapas the rate was 3.5 children. During the first decade of this century, the decline continued, but was less pronounced: in 2010, the rate in Mexico City was 1.9 and in Chiapas 3.2; This year, this entity is the only one with a rate above three children per woman.

In the right panel of Table 7.1, with cohort follow-up up to seven years after birth, the states with low fertility rates show no change compared to those with the shorter follow-up period. In contrast, the states with high fertility rates do have higher values. For example, in 1990, the average number of children in Guerrero exceeded 5 per woman, while in Oaxaca, Puebla, and Chiapas it was around 4.7. Guerrero (0.7 children) and Chiapas (0.4) showed the greatest increase in the **total fertility rate (TFR)** compared to the age-4 record. With the trend toward improved record-keeping over time, by 2010, the differences between the four- and seven-year series were small, even in the states with the highest fertility rates: only in Chiapas did the final number of children recorded up to age eight exceed by 0.1 the number recorded up to age four.

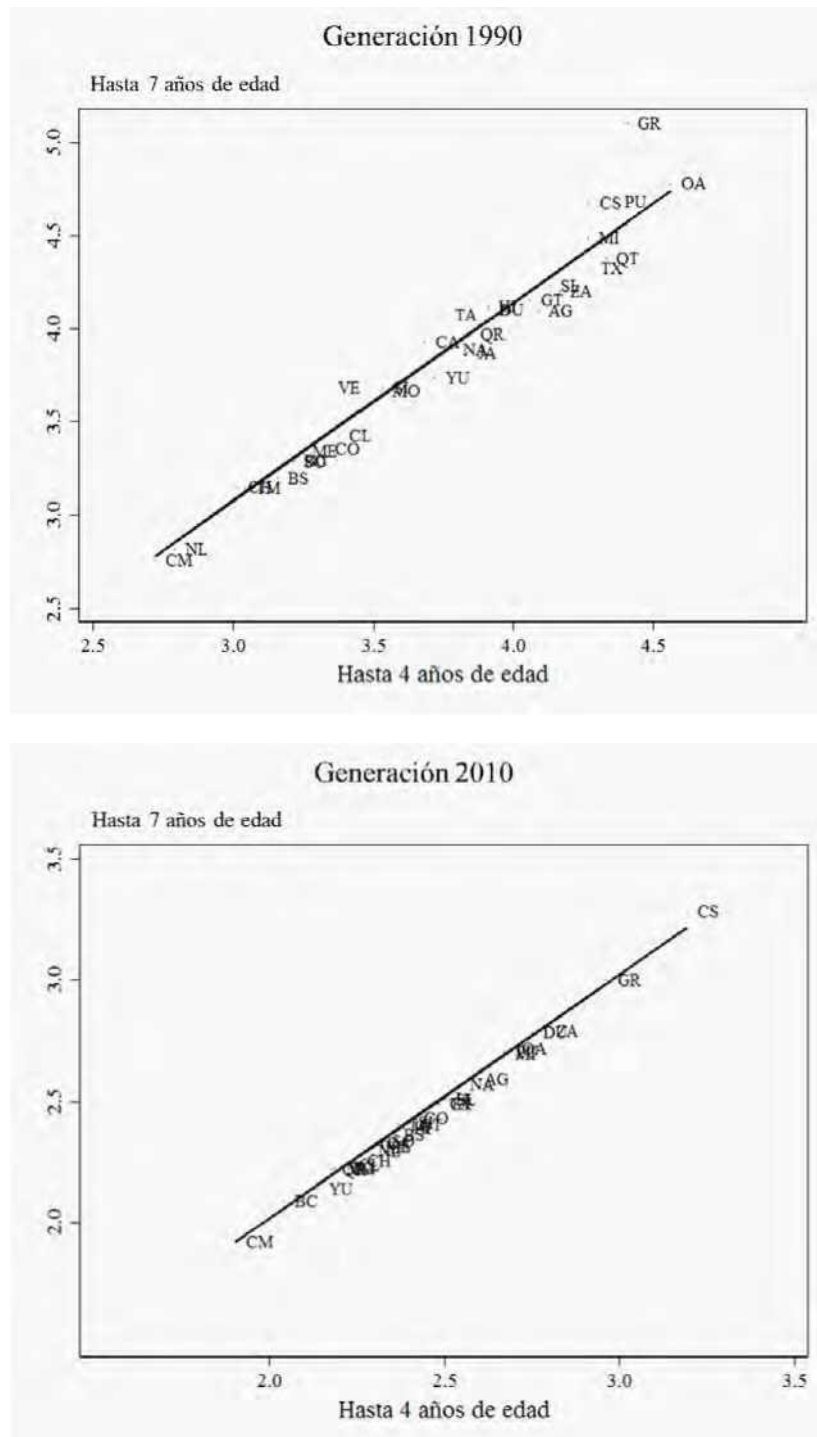
Figure 7.1 shows the correlation between the two **TGF estimates** for the calendar years we are analyzing. In both panels, a close linear association between the two estimates is evident (correlation coefficients of 0.973 in 1990 and 0.998 in 2010), especially in 2010. In both panels, the ordinary least squares regression line is included, whose slope (1.12 in 1990 and 1.03 in 2010) indicates that, on average, the distance between the **TGF** of any two federal entities widens by 12 and 3%, respectively, when using the record up to 7 years of age, instead of using the record up to 4 years of age.

¹ Again, we assumed that the proportion of births registered between two successive ages remains constant from year to year, to complete the registration of those born from 2009 onwards.

Federal entity	Up to 4 years of age						Up to 7 years of age					
	1990	1995	2000	2005	2010	2015	1990	1995	2000	2005	2010	2015
Aguascalientes	4.09	3.45	3.15	2.70	2.58	2.39	4.10	3.46	3.16	2.71	2.59	2.40
Baja California	3.22	2.66	2.60	2.18	2.04	2.10	3.29	2.73	2.71	2.24	2.09	2.17
Baja California Sur	3.16	2.74	2.78	2.40	2.35	2.09	3.20	2.78	2.81	2.42	2.37	2.12
Campeche	3.68	3.14	2.66	2.23	2.30	2.19	3.93	3.28	2.77	2.28	2.33	2.21
Coahuila	3.32	2.88	2.87	2.46	2.41	2.52	3.36	2.92	2.90	2.49	2.43	2.53
Colima	3.38	2.79	2.51	2.30	2.22	1.93	3.43	2.83	2.54	2.35	2.24	1.95
Chiapas	4.27	3.79	3.49	3.09	3.19	2.81	4.68	4.34	3.83	3.33	3.28	2.85
Chihuahua	3.01	2.70	2.78	2.43	2.25	2.22	3.15	2.84	2.87	2.49	2.26	2.22
Mexico City	2.72	2.26	2.08	1.92	1.90	1.76	2.76	2.29	2.11	1.95	1.92	1.78
Durango	3.91	3.46	3.14	2.73	2.75	2.63	4.10	3.60	3.23	2.79	2.79	2.66
Guanajuato	4.06	3.50	3.16	2.65	2.48	2.23	4.16	3.55	3.19	2.67	2.49	2.24
Warrior	4.40	4.19	3.48	3.10	2.96	2.47	5.11	4.70	3.85	3.25	3.00	2.49
Gentleman	3.91	3.36	2.86	2.49	2.38	2.12	4.12	3.46	2.93	2.53	2.39	2.13
Jalisco	3.83	3.14	2.94	2.54	2.49	2.25	3.87	3.17	2.97	2.56	2.51	2.26
Mexico	3.24	2.77	2.64	2.49	2.30	2.05	3.34	2.83	2.68	2.51	2.31	2.06
Michoacán	4.26	3.49	3.08	2.68	2.67	2.44	4.49	3.65	3.16	2.74	2.69	2.46
Morelos	3.53	2.72	2.48	2.26	2.19	2.06	3.66	2.88	2.59	2.32	2.23	2.10
Nayarit	3.78	3.15	2.80	2.57	2.54	2.24	3.89	3.23	2.88	2.62	2.57	2.27
Nuevo León	2.79	2.50	2.65	2.33	2.28	2.18	2.82	2.52	2.67	2.35	2.30	2.19
Oaxaca	4.56	4.14	3.34	2.94	2.69	2.51	4.78	4.27	3.45	3.00	2.72	2.54
Puebla	4.36	3.78	3.30	2.91	2.67	2.68	4.69	4.03	3.43	2.97	2.70	2.72
Querétaro	4.33	3.51	2.98	2.59	2.40	2.29	4.38	3.53	3.03	2.60	2.40	2.30
Quintana Roo	3.84	3.05	2.79	2.29	2.18	2.20	3.97	3.13	2.87	2.34	2.22	2.26
San Luis Potosí	4.13	3.59	3.29	2.78	2.50	2.28	4.23	3.65	3.32	2.80	2.51	2.28
Sinaloa	3.53	3.19	2.79	2.50	2.39	2.09	3.68	3.27	2.84	2.53	2.41	2.12
Sonora	3.21	2.87	2.86	2.51	2.32	2.00	3.29	2.92	2.90	2.55	2.34	2.02
Tabasco	3.75	3.13	2.87	2.60	2.37	2.26	4.08	3.27	2.94	2.64	2.41	2.30
Tamaulipas	3.04	2.65	2.63	2.31	2.20	2.12	3.15	2.74	2.70	2.34	2.23	2.15
Tlaxcala	4.27	3.56	3.12	2.65	2.48	2.32	4.33	3.60	3.14	2.67	2.49	2.33
Veracruz	3.34	2.94	2.70	2.34	2.28	2.00	3.68	3.14	2.80	2.40	2.31	2.01
Yucatán	3.72	3.13	2.78	2.20	2.14	2.05	3.73	3.16	2.80	2.21	2.14	2.06
Zacatecas	4.16	3.56	3.17	2.82	2.79	2.55	4.21	3.59	3.18	2.83	2.79	2.55

Source: Vital Statistics 1985-2015.

Figure 7.1. Correlation between global fertility rates and births registered up to 4 and 7 years of age for



Source: Estimates based on vital statistics of births 1983-2015.

7.2 Pregnancy stories

The pregnancy history data from the surveys allows for a more nuanced analysis of fertility and, as mentioned, provides both the numerator and denominator for estimating rates, which is a significant strength since some data deficiencies tend to cancel each other out. In the case of estimates for the states, as mentioned at the beginning of the chapter, the problem lies in the variations associated with the sample. To assess the accuracy of the estimates from the different surveys, Table 7.2 presents the **TFR values** with the lower and upper limits of the 90% confidence intervals.

Estimates of the **total family income (TFR)** in the states can generally be considered accurate based on the length of the confidence interval, but not necessarily based on the indicator's value. Exceptions include the estimates using data from the 2006 National Survey on **Demographic Dynamics (ENADID)**, which have very wide confidence intervals, exceeding one child in several states. To a lesser extent, but still, some states also have wide intervals in the other surveys. The 2014 **ENADID** provides the most accurate estimates for all states, making it a solid instrument on which to base state estimates for reconciliation.

It is observed that, in general, the ranking of the surveys coincides with that of the vital statistics. In the case of the surveys, there are a greater number of entities whose ranking does not change gradually.

7.3 Contraception

In order to have more elements to propose estimates on the fertility level of the federal entities, we present in graph 7.2, for each of the five surveys, scatter diagrams of the total fertility rate and the proportion of women of reproductive age in a conjugal union who declare using contraceptives at the time of the interview, and the ordinary least squares regression line that fits the data.

7.4 Fertility level in the federal entities 1990-2015

Next, we present estimates of the **TFR** from 1990 to 2015 from various sources and using different methodologies for each state. In addition to the vital statistics and surveys already mentioned, we include two TFR estimates **using** census data: one using the indirect method of intercensal parity increase and the other using data on the date of birth of the last child, which are presented in Table 7.3. We also include, as a lower bound, the parity of women aged 30 to 34 in the 2015 census and survey, and we also include the rates obtained from birth certificate data and the female population data from Chapter 6, which are

ENADID 1992 (1988-1992)				ENADID 1997 (1992-1997)				ENADID 2006 (2002-2006)				
Rat	Error	Confidence	interval 90%	Rat	Error	Confidence	interval 90%	Rat	Error	Confidence	interval 90%	
Federal entity	glo	stan	Lo	Superio	glo	stan	Lo	Superio	glob	stan	Lo	Sup
	bal	dar	wer	r	bal	dar	wer	r	al	dard	wer	erio
Aguascalientes									2,691	0.163	2,215	3,166
Baja California	4.19	0.167	3.91	4.47	3.67	0.124	3.46	3.87	2,530	0.214	1916	3,163
Baja California Sur	3.54	0.167	3.26	3.83	3.00	0.125	2.79	3.20	2,652	0.200	2,067	3,237
Campeche	3.30	0.157	3.04	3.57	2.88	0.113	2.70	3.07	2,224	0.141	1,814	2,635
Coahuila	4.02	0.143	3.78	4.26	3.31	0.135	3.08	3.53	2,739	0.157	2,280	3,196
Colima	3.43	0.144	3.19	3.68	3.06	0.071	2.95	3.18	2,152	0.188	1,602	2,702
Chiapas	3.40	0.171	3.11	3.69	3.12	0.134	2.90	3.34	2,914	0.208	2,305	3,522
Chihuahua	4.79	0.172	4.49	5.08	3.90	0.171	3.62	4.18	2,450	0.180	1926	2,974
Mexico City	3.55	0.114	3.36	3.75	3.11	0.076	2.98	3.23	2,038	0.117	1,696	2,379
Durango	2.47	0.118	2.27	2.67	2.17	0.081	2.04	2.30	2,862	0.180	2,337	3,388
Guanajuato	4.48	0.264	4.03	4.93	3.72	0.136	3.49	3.94	2,800	0.159	2,344	3,275
Warrior	4.26	0.178	3.95	4.56	3.57	0.130	3.36	3.78	3,326	0.214	2,702	3,949
Gentleman	4.76	0.230	4.37	5.15	4.09	0.116	3.90	4.28	2,709	0.205	2,190	3,387
Jalisco	3.72	0.176	3.42	4.02	3.53	0.130	3.31	3.74	2,726	0.134	2,336	3,115
Mexico	4.47	0.321	3.92	5.01	3.55	0.107	3.37	3.73	2,427	0.141	2016	2,839
Michoacán	3.63	0.177	3.33	3.93	2.95	0.106	2.78	3.13	2,761	0.177	2,248	3,279
Morelos	4.77	0.239	4.36	5.18	3.89	0.184	3.59	4.20	2,414	0.159	1948	2,879
Nayarit	3.26	0.167	2.98	3.54	3.20	0.094	3.04	3.35	2,811	0.159	2,348	3,275
Nuevo León	4.01	0.175	3.71	4.31	3.38	0.104	3.21	3.55	2,100	0.146	1,763	2,618
Oaxaca	2.79	0.092	2.63	2.94	2.75	0.117	2.56	2.94	2,217	0.141	1,806	2,628
Puebla	4.86	0.140	4.62	5.10	3.80	0.190	3.48	4.11	2,618	0.136	2,220	3,017
Querétaro	4.66	0.204	4.31	5.00	4.11	0.124	3.90	4.31	2,574	0.162	2,099	3,048
Quintana Roo	4.54	0.212	4.18	4.90	3.43	0.128	3.22	3.64	2,770	0.161	2,300	3,241
San Luis Potosí	4.10	0.183	3.79	4.41	3.57	0.100	3.40	3.73	3,029	0.180	2,502	3,556
Sinaloa	4.50	0.177	4.20	4.81	3.97	0.128	3.76	4.19	2,453	0.160	1984	2,921
Sonora	3.34	0.111	3.15	3.53	3.64	0.079	3.51	3.77	2,407	0.162	1933	2,881
Tabasco	3.18	0.141	2.94	3.42	3.18	0.063	3.08	3.28	2,467	0.123	2,109	2,825
Tamaulipas	3.85	0.218	3.48	4.22	3.36	0.145	3.12	3.60	2,204	0.246	1,576	3,012
Tlaxcala	3.20	0.199	2.86	3.54	2.99	0.090	2.85	3.14	2,665	0.157	2,206	3,124
Veracruz	4.04	0.157	3.78	4.31	3.59	0.110	3.41	3.77	2,504	0.130	2,125	2,883
Yucatán	3.60	0.282	3.12	4.09	3.21	0.138	2.99	3.44	2,421	0.163	1945	2,897
Zacatecas	4.21	0.234	3.81	4.61	3.39	0.100	3.22	3.55	2,731	0.168	2,239	3,222

Federal entity	ENADID 2009				ENADID 2014			
	Rate global	Error is standar d	90% Confidence Interval		Rate glob al	Mist ake stand ard	90% Confidence Interval	
			Lower	Upper			Lower	Upper
Aguascalientes	2.92	0.098	2.76	3.08	2.20	0.078	2.07	2.33
Baja California	2.44	0.096	2.28	2.60	2.07	0.089	1.92	2.22
Baja California Sur	2.32	0.100	2.15	2.48	2.24	0.093	2.09	2.39
Campeche	2.47	0.080	2.33	2.60	2.05	0.064	1.94	2.15
Coahuila	2.59	0.099	2.42	2.75	2.54	0.083	2.41	2.68
Colima	2.34	0.118	2.15	2.53	2.22	0.080	2.09	2.35
Chiapas	3.09	0.147	2.85	3.34	2.88	0.103	2.71	3.05
Chihuahua	2.50	0.093	2.35	2.66	2.22	0.080	2.08	2.35
Mexico City	2.08	0.077	1.95	2.21	1.44	0.060	1.34	1.54
Durango	2.95	0.105	2.77	3.12	2.41	0.084	2.27	2.55
Guanajuato	2.83	0.104	2.66	3.00	2.40	0.071	2.28	2.52
Warrior	2.95	0.120	2.75	3.15	2.53	0.103	2.36	2.70
Gentleman	2.49	0.119	2.29	2.68	2.22	0.082	2.08	2.36
Jalisco	2.87	0.115	2.68	3.06	2.28	0.069	2.17	2.39
Mexico	2.36	0.106	2.19	2.54	2.08	0.076	1.96	2.21
Michoacán	2.56	0.126	2.36	2.77	2.37	0.071	2.25	2.49
Morelos	2.23	0.097	2.07	2.39	2.13	0.085	1.99	2.27
Nayarit	2.87	0.101	2.71	3.04	2.49	0.092	2.34	2.65
Nuevo León	2.41	0.094	2.26	2.57	2.11	0.084	1.97	2.25
Oaxaca	2.70	0.151	2.45	2.95	2.38	0.090	2.24	2.53
Puebla	2.61	0.099	2.45	2.77	2.38	0.072	2.27	2.50
Querétaro	2.61	0.097	2.46	2.77	2.15	0.077	2.03	2.28
Quintana Roo	2.54	0.102	2.37	2.71	2.11	0.079	1.98	2.24
San Luis Potosí	2.76	0.102	2.60	2.93	2.30	0.083	2.16	2.43
Sinaloa	2.43	0.088	2.29	2.58	2.15	0.070	2.04	2.27
Sonora	2.63	0.112	2.44	2.81	2.18	0.075	2.06	2.30
Tabasco	2.34	0.100	2.18	2.51	2.25	0.077	2.13	2.38
Tamaulipas	2.36	0.096	2.20	2.52	2.31	0.081	2.17	2.44
Tlaxcala	2.57	0.089	2.43	2.72	2.21	0.065	2.10	2.31
Veracruz	2.53	0.109	2.35	2.71	2.16	0.080	2.03	2.30
Yucatán	2.33	0.093	2.18	2.48	1.94	0.078	1.81	2.07
Zacatecas	3.06	0.130	2.85	3.28	2.62	0.082	2.48	2.75

Source: National Survey of Demographic Dynamics 1992, 1997, 2006, 2009 and 2014.

Figure 7.2. Correlation between global fertility rates and the

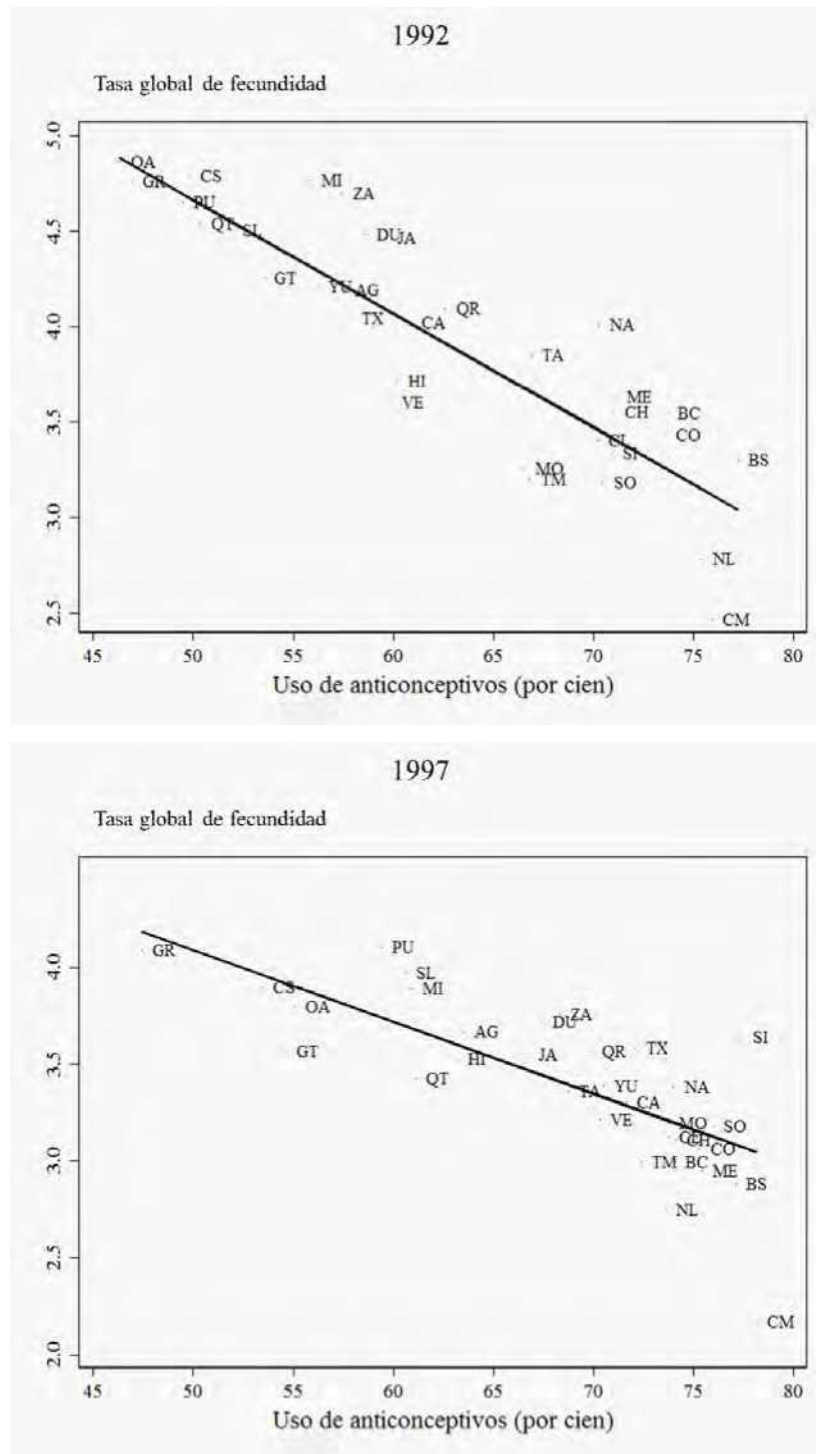


Figure 7.2.
(Continued)

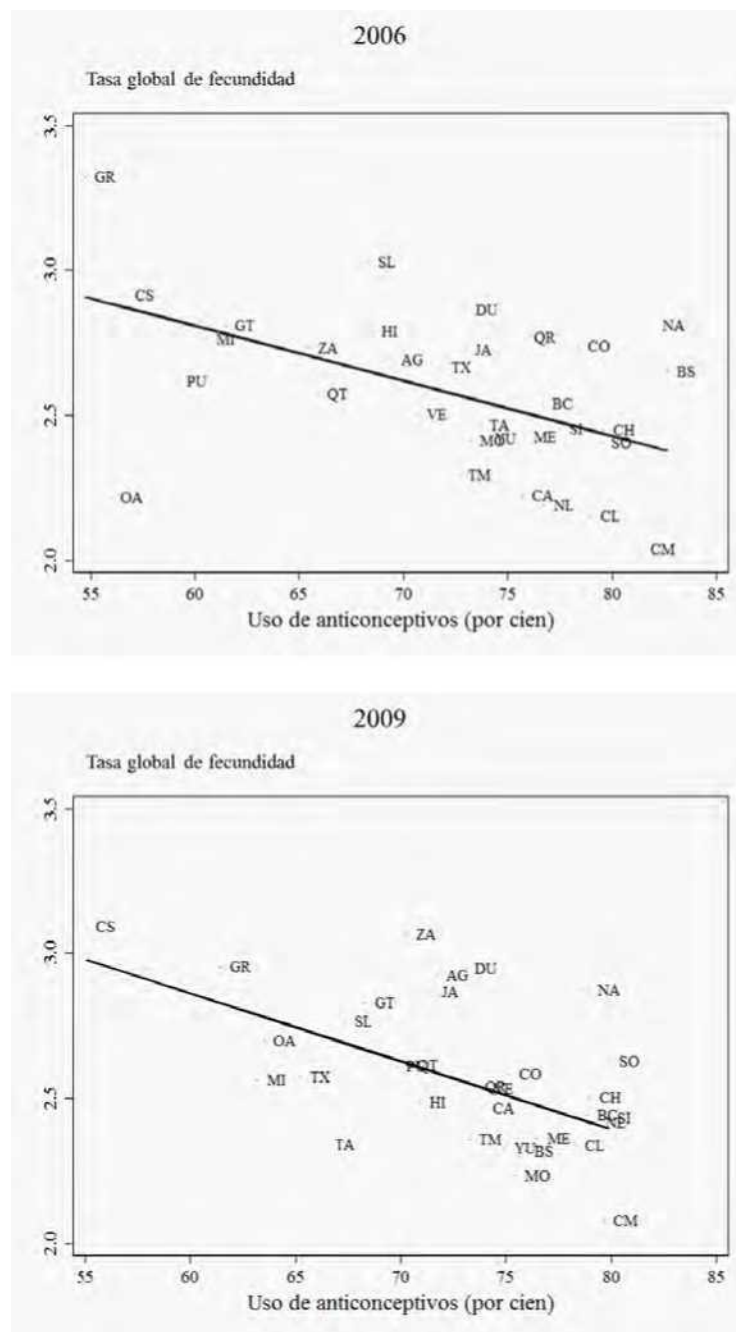
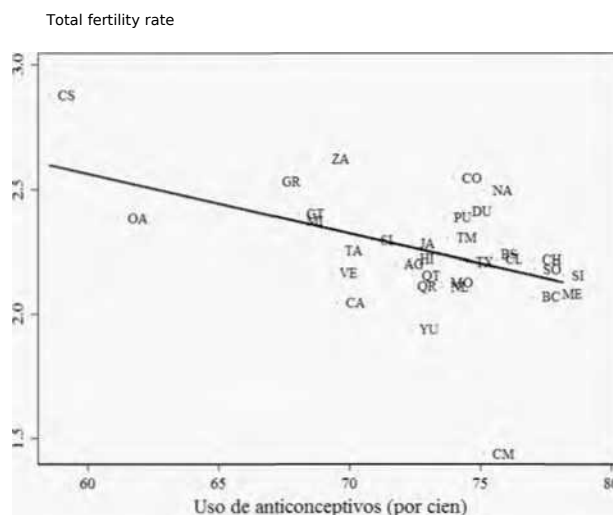


Figure
7.2.

2014



Source: National Survey of Demographic Dynamics 1992-2014.

They are reproduced in table 7.4.

Based on these assessments, a commentary is made on the situation in each of the states, and plausible TFR values are proposed for the period 1990-2015. In the results, the level of the estimates prepared using vital statistics and the birth certificate is always lower than the estimates obtained with survey and census data. We include them because, although at a lower level, they provide a good indication of the rate of decline. We do not analyze all the estimates for each of the states because it would result in extremely repetitive writing, and also because in very few cases do we use vital statistics as the primary element for defining the proposed fertility level.

We also wish to point out that, given the very wide confidence intervals in the 2006 National Survey on Demographic Dynamics (ENADID), the estimates derived from this survey often do not align with the trends indicated by other surveys and census data. We include the average value for reference, but we do not analyze it for each individual state.

Agascalientes. The estimates are grouped into two distinct levels. On the one hand, vital statistics, birth certificates, and census parity data all point to a slow but uninterrupted decline from approximately 4.0 children per woman in the early 1990s to 2.0 in 2015. The agreement between the two vital statistics series is noteworthy, reflecting the timely registration of births; the birth certificate also appears to have coverage very close to that of the Civil Registry since its first year of implementation. However, the level seems to be underestimated because estimates based on survey data, the date of birth of the last child, and the increase in interconception parity all point to a higher level.

Federal entity	Total fertility rate of intercensal parity increases				2010-2015	Total fertility rate of the last child		
	1990-1995	1995-2000	2000-2005	2005-2010		2000	2010	2015
Aguascalientes	3.92	3.10	3.01	2.45	2.59	3.11	2.56	2.46
Baja California	3.61	2.94	2.70	2.34	2.15	2.84	2.21	2.04
Baja California Sur	3.27	2.53	2.62	2.23	2.10	2.60	2.37	2.20
Campeche	3.76	3.34	2.61	2.00	2.38	2.84	2.32	2.36
Coahuila	3.45	2.75	2.78	2.37	2.59	2.67	2.50	2.48
Colima	3.44	2.66	2.59	2.10	2.17	2.56	2.23	2.12
Chiapas	4.09	3.83	3.33	2.82	2.88	3.40	3.10	2.89
Chihuahua	3.59	2.92	2.92	2.51	2.27	2.84	2.50	2.25
Mexico City	2.54	2.05	1.96	1.70	1.27	2.00	1.71	1.52
Durango	3.92	3.15	3.09	2.59	2.56	3.02	2.85	2.54
Guanajuato	4.20	3.43	3.02	2.35	2.31	3.22	2.42	2.25
Warrior	4.64	4.42	3.34	2.75	2.65	3.63	2.91	2.56
Gentleman	3.64	3.14	2.69	2.20	2.28	2.78	2.39	2.15
Jalisco	3.72	3.00	2.86	2.35	2.40	2.92	2.37	2.28
Mexico	3.39	2.75	2.61	2.16	1.90	2.66	2.22	1.99
Michoacán	4.20	3.60	3.06	2.39	2.64	3.13	2.59	2.48
Morelos	3.39	2.78	2.55	2.11	2.15	2.65	2.21	2.02
Nayarit	3.74	2.95	2.90	2.33	2.61	2.91	2.50	2.50
Nuevo León	3.11	2.47	2.58	2.23	2.28	2.47	2.32	2.15
Oaxaca	4.10	3.94	3.00	2.41	2.54	3.20	2.57	2.36
Puebla	4.07	3.65	2.94	2.37	2.40	3.13	2.53	2.30
Querétaro	3.77	3.01	2.62	2.04	2.17	2.93	2.30	2.13
Quintana Roo	3.34	2.72	2.55	1.97	2.21	2.94	2.38	2.14
San Luis Potosí	4.10	3.55	3.00	2.42	2.38	3.17	2.52	2.22
Sinaloa	3.63	2.84	2.69	2.32	2.42	2.78	2.33	2.26
Sonora	3.49	2.84	2.83	2.47	2.21	2.76	2.50	2.24
Tabasco	3.63	3.10	2.78	2.15	2.21	2.73	2.39	2.27
Tamaulipas	3.31	2.67	2.71	2.31	2.45	2.58	2.52	2.32
Tlaxcala	3.72	3.07	2.81	2.25	2.29	2.92	2.45	2.19
Veracruz	3.50	3.01	2.61	2.12	2.27	2.65	2.26	2.19
Yucatán	3.42	3.08	2.52	2.00	2.15	2.77	2.15	2.14
Zacatecas	4.21	3.34	3.27	2.50	2.67	3.15	2.69	2.57

Source: Population censuses 1990, 2000 and 2010 and intercensal survey 2015.

Federal entity	Total fertility rate from birth certificate				Parity 30-34 years			
	2012	2013	2014	2015	1990	2000	2010	2015
Aguascalientes	2.56	2.51	2.47	2.40	3.23	2.57	2.16	2.08
Baja California	2.05	1.99	1.93	1.86	2.69	2.38	2.08	2.01
Baja California Sur	2.21	2.11	2.10	2.03	2.88	2.33	2.01	1.95
Campeche	2.11	2.15	2.10	2.12	3.28	2.77	2.10	1.99
Coahuila	2.46	2.48	2.48	2.46	2.97	2.46	2.18	2.11
Colima	2.16	2.05	2.03	1.89	3.09	2.43	2.00	1.88
Chiapas	2.01	2.04	2.08	2.05	3.88	3.22	2.62	2.49
Chihuahua	2.15	2.10	2.06	2.08	2.85	2.43	2.25	2.12
Mexico City	1.83	1.80	1.79	1.70	2.14	1.74	1.45	1.27
Durango	2.55	2.55	2.44	2.41	3.51	2.79	2.37	2.20
Guanajuato	2.43	2.34	2.28	2.24	3.51	2.74	2.14	1.95
Warrior	2.23	2.27	2.24	2.15	3.76	3.22	2.60	2.36
Gentleman Jalisco	2.13	2.19	2.10	2.04	3.44	2.76	2.19	2.04
	2.37	2.32	2.30	2.19	3.13	2.46	2.06	1.93
Mexico	2.19	2.13	2.08	2.00	2.99	2.39	2.01	1.83
Michoacán	2.52	2.48	2.39	2.31	3.57	2.82	2.22	2.10
Morelos	2.11	2.11	2.06	2.01	2.99	2.45	2.01	1.87
Nayarit	2.35	2.35	2.21	2.09	3.40	2.68	2.23	2.14
Nuevo León	2.02	2.12	2.17	2.19	2.66	2.14	1.87	1.83
Oaxaca	2.20	2.23	2.28	2.19	3.61	3.00	2.32	2.15
Puebla	2.42	2.38	2.30	2.28	3.46	2.83	2.27	2.11
Querétaro	2.32	2.26	2.26	2.19	3.40	2.63	2.00	1.81
Quintana Roo	2.08	2.06	2.07	2.03	3.20	2.49	1.99	1.86
San Luis Potosí	2.26	2.21	2.24	2.16	3.47	2.81	2.24	2.03
Sinaloa	2.24	2.20	2.11	2.02	3.27	2.57	2.17	2.06
Sonora	2.16	2.05	2.05	1.98	2.85	2.41	2.19	2.07
Tabasco	2.37	2.44	2.34	2.36	3.51	2.75	2.16	2.00
Tamaulipas	2.18	2.13	2.13	2.11	2.75	2.30	2.03	2.02
Tlaxcala	2.50	2.37	2.29	2.21	3.42	2.67	2.15	2.00
Veracruz	2.02	2.06	2.03	1.93	3.08	2.53	2.07	1.95
Yucatán	2.03	1.99	2.03	2.02	3.16	2.55	1.96	1.82
Zacatecas	2.45	2.48	2.40	2.36	3.78	2.80	2.25	2.12

Source: Population censuses 1990, 2000 and 2010, intercensal survey 2015 and birth certificate 2012-2015.

high, particularly for older years. Furthermore, given the close relationship between the TFR of pregnancy histories and the proportion of women using contraceptives in this region, it is plausible to assume that surveys provide the best estimates.

Baja California. The various estimates agree on a continuous decline starting in the 1970s. Those obtained using the birth date of the last child in the census coincide with the survey values and are higher than those from vital statistics. In all cases, the survey and census values are above the parity values for 30-34 years. In all surveys, the fertility rate is higher than what would correspond to the level of contraceptive use, suggesting good fertility data capture from this source.

Baja California Sur. The decline in the fertility rate is continuous, although there are periods of slight decrease, especially when the rate is approaching two children per woman. Estimates from surveys and the date of birth of the last child tend to coincide and are above vital statistics and the 30-34 age parity. In recent years, the total fertility rate (TFR) has fallen below the replacement level. Contraceptive use is generally consistent with the fertility rate reported in the surveys.

Campeche. In general, survey estimates of the increase in intercensal parity and the date of the last live birth indicate a trend toward a rapid decline in the 1990s, from four to slightly more than two children per woman. In the first decade of this century, there are some discrepancies in the estimates; in particular, the 2014 ENADID value for 2012 is extremely low, even compared to the 30-34 parity period, and it also does not align with the less frequent use of contraceptives. The census estimate of the date of the last live birth appears to be closer to the actual value.

Coahuila. Survey estimates align with census data regarding fertility rates over the past 25 years, showing a very gradual decline of approximately one child per woman, reaching a level of 2.5 children in the last year. The fertility rate in this state is slightly higher than expected given the high level of contraceptive use.

Colima. Estimates agree that there was a sharp decline in the 1990s, reaching levels close to replacement at the beginning of the 21st century. Values obtained from survey and census data indicate levels around replacement in recent years. The level of use is high, consistent with the fertility rates reported in the surveys.

Chiapas. Survey estimates, consistent with census data, indicate a sharp decline in the total fertility rate (TFR) , which has slowed in this century and remained close to three children per woman in recent years. The two vital statistics series differ in the most distant years, but practically coincide from 2010 onward, reflecting the increasing timely registration of births, though they consistently show lower levels than other estimates. Only the birth certificate falls significantly short, highlighting the difficulties in its implementation in [the region/country].

This entity. The level of use is the lowest in the country, lower than expected for the TGF value in the various surveys.

Chihuahua. Survey estimates coincide with those obtained from censuses. The level has reached close to replacement in recent years, with a high level of contraceptive use.

Mexico City. Estimates agree on the very low fertility rate, the lowest in the country, but differ regarding the level and trend. For recent years, estimates based on the birth date of the last child and vital statistics appear to be the closest to reality, showing a rate close to 1.5 children per woman. The level of fertility use is high, but below what would correspond to the fertility rate indicated by the surveys.

Durango. Data from the 1992, 1997, and 2009 surveys provide values that coincide with those obtained from census data and suggest a sharp decline in the 1990s, starting from 4.5 children, and continuing more slowly in recent years, reaching a TFR value of 2.35 in 2015. In all surveys, the fertility level is high for the relatively high use of contraception.

Guanajuato. Survey estimates and census data agree, indicating a gradual decline since the 1990s, from just over four children per woman to 2.3 in the last year analyzed. The fertility rate is generally slightly higher than expected based on contraceptive use.

Guerrero. Survey estimates indicate that it was one of the states with the highest fertility rates in the country during the 1990s, when the total fertility rate (TFR) was close to five children per woman. Census estimates suggest even higher levels than those found in the surveys, which coincides with the relatively low use of contraceptives.

Hidalgo. Fertility rates are lower, and the various estimates show greater agreement than in many other states, concurring that a gradual decline has been observed, even in recent years. The slightly higher levels reported in surveys and census data suggest a decrease from slightly less than four children per woman at the beginning of the 1990s to a replacement level in 2015. For its current usage level, the fertility rate is only slightly lower than expected in all surveys.

Jalisco. Survey estimates reasonably coincide with census data in indicating a rapid initial decline in the 1990s, which slowed down at the beginning of this century. The total fertility rate (TFR) would have decreased from a value close to 4.5 in 1990 to a low of 2.25 in 2015. The fertility rate is in agreement with the level of contraceptive use.

Mexico. The agreement between survey estimates and census data in describing a sharp decline that has slowed in recent years is remarkable. By 2010, the replacement level had already been reached, and the decline appears to have continued over the last five years, reaching a rate of 2.0 in 2015. The fertility rate reported in the surveys is in line with, or slightly above, what would correspond to the high level of fertility use.

Michoacán. Survey and census estimates agree in indicating a level

High fertility rates with a rapid downward trend in the 1990s that slowed from the second half of the 21st century onward. The 2009 and 2014 National Surveys on Adult Development (**EN ADID**) provide values lower than those obtained from census data for similar periods. These low **total fertility rates** do not correspond to the low level of fertility use, suggesting an underestimation of the surveys for recent years.

Morelos. The survey and census data show a high degree of agreement, indicating a gradual decline from relatively low levels in the 1990s, reaching replacement level in 2010 and continuing to fall in recent years. The fertility rate closely matches contraceptive use in all surveys except for the 1992 survey, when fertility was low due to the limited use of contraceptives.

Nayarit. Survey and census estimates are reasonably consistent and indicate a sharp decline in the 1990s, which has slowed considerably in the current century. In this state, fertility use is very high, suggesting a lower fertility rate than that observed in the surveys. In 2015, a total fertility rate (**TFR**) of 2.4 seems appropriate to the 2014 survey and census estimates.

Nuevo León. The agreement between the estimated values is generally good. In 1990, the fertility rate was below three children per woman and has since declined steadily until falling below the replacement level in 2015. The level of use is consistent with the survey estimates.

Oaxaca. The estimates do not perfectly align, but based on data from some surveys and censuses, there are elements that define a relatively clear trend. In 1990, the state had the highest total fertility rate (**TFR**) of all the federal entities, at 4.9 children per woman, which declined rapidly in the 1990s and more slowly in recent years. In 2015, the **TFR** was 2.30 children per woman. Contraceptive use is among the lowest and would correspond to a higher fertility level than that observed in all the surveys.

Puebla. The agreement of the estimates from the different sources is good, and it is possible to observe a clear trend of very high levels at the beginning of the nineties (4.7 children per woman), a pronounced decrease in the decade, which has continued slowly until recent years, in which even the estimates of the vital statistics agree in indicating a value of 2.3 for 2015. The levels of use do not always coincide with the expected fertility but the differences are not large.

Querétaro. Survey and census estimates coincide, except for the 2009 **ENADID**, which shows a value that seems too high given the general trend of a marked decline observed in the 1990s, a decline that slowed in the 21st century but continued into recent years, where the fertility rate is below replacement level. Use of contraceptives has increased significantly and, in 2014, perfectly matched the total fertility rate (**TFR**).

Quintana Roo. Survey and census estimates generally agree, indicating a notable decline in the 1990s, which continued in subsequent years, albeit at a slower pace. In 2015, the total fertility rate (**TFR**) fell below the replacement level of 2.11 children per woman. Fertility levels correlate very well with usage levels in all surveys.

San Luis Potosí. The agreement between the different estimates is high and indicates

An accelerated decline that breaks into a slower decline at the beginning of the current century, and which continues into recent years. The total fertility rate (TFR) starts at 4.5 in 1990 and reaches almost the replacement level (2.25) in 2015. The level of use increases significantly during this period, with values close to those expected for the fertility levels observed in the survey data.

Sinaloa. The values from the various estimates coincide except for the 1997 ENADID survey , which reported a TFR of 3.6. This figure does not align with the trend observed in other sources, nor with the level of contraceptive use in that survey, which was similar to that of Baja California Sur and Mexico City, both states with much lower fertility rates. It is worth noting that in 2009 and 2014, Sinaloa maintained one of the highest contraceptive use rates, but with significantly lower fertility levels: in 2015, the TFR was 2.13.

Sonora. Since 1990, the fertility rate has been relatively low and has been declining steadily until recent years. However, in 1997, the fertility rate began to rise significantly relative to the fertility use rate, which is among the highest in the country in the last four surveys. Similar to Sinaloa, this discrepancy exists between fertility rates and use, but by 2015, the total fertility rate (TFR) had fallen below the replacement level.

Tabasco. The agreement between survey and census estimates is reasonable, although the estimate for the date of birth of the last child in 1999 is too low, lower than the 30-34 age range in the following year. In 1990, the total fertility rate (TFR) was close, and two decades later it was 2.3, very close to replacement level in 2015. In 2009, and to a lesser extent in 2014, the fertility rate was well below what would be expected due to the reduced use of contraceptives.

Tamaulipas. According to various sources, the fertility rate is relatively low, with a total fertility rate (TFR) of just over 3.0 at the beginning of the 1990s, and it has been gradually declining until it is close to, but above, the replacement level in recent years. Estimates based on pregnancy histories and the date of birth of the last child in the censuses are consistent. The level of use in the surveys is consistent with the TFR values reported in the surveys.

Tlaxcala. Survey estimates coincide with census data, indicating a slow but steady decline over the 25 years analyzed. Usage levels fluctuate from one survey to another: they increase significantly between 1992 and 1997, decrease in 2009, and then rise again in 2014; however, the points on the scatter plots do not deviate substantially from the fitted line.

Veracruz. Survey estimates almost always coincide with the increase in intercensal parity; estimates using data on the birth date of the last child in 1999 and 2009-2010 fall below the trend suggested by the survey figures. In 2012-2014, all estimates are close to replacement level. Except for the 1992 survey, when use was low and fertility was not as high, the other surveys show a strong correlation between the level of use and the TFR value.

Yucatán. The trend established by the various estimates is quite consistent and suggests a continuous and pronounced decline. In recent years, usage has fallen below replacement level. The level of use in the surveys is in accordance with

the level of fertility, except in 2014 when a slightly higher overall rate value would be expected.

Zacatecas. In the 1990s, the downward trend was clear, as suggested by both surveys and census estimates. In 2000, the rate of decline appeared to slow, but the 2009 survey showed a high **TFR value**, which did not align with the lower level suggested by other estimates; the level of contraceptive use in this survey also appeared to be lower than the observed level. However, the **TFR estimate** based on the 2014 survey data aligns with the other estimates and with the level of contraceptive use.

7.5 Proposed fertility level for the work-life balance exercise

Based on the preceding analysis, we obtained the proposed total fertility rates for each of the federal entities in 1990, 1995, 2000, 2005, 2010, and 2015. As mentioned in the preceding paragraphs, we considered estimates obtained from pregnancy histories in surveys, the intercensal increase in parity, the birth date of the last child from population censuses, and the parity of women aged 30 to 34 in the censuses. To provide a sense of continuous trend, the estimates used as the basis for the analysis also included estimates from vital statistics and birth certificates. In all cases, we considered the level of contraceptive use. Table 7.5 presents the proposed values.

Once the total fertility rates have been chosen, it is necessary to superimpose an age-specific structure of rates on them. When the chosen **TFR coincides with one of the sources considered, the age-specific rates that generate the TFR** are used ; if the value does not correspond to a particular source, the age composition of the rates obtained from vital statistics up to registration at age 4 is used, considering that, due to the volume of births in the numerator of the rate, the age structure must be adequate.

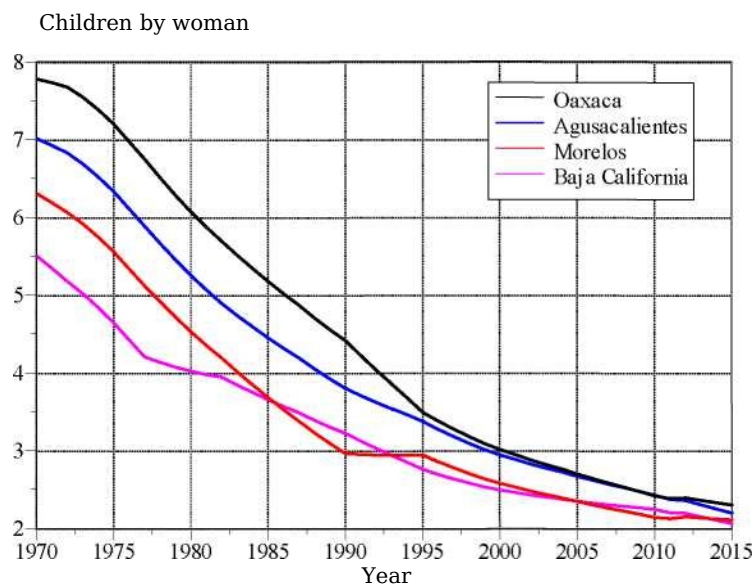
7.6 Age-specific fertility rates for each year of the period 1970-2015

For state fertility data prior to 1990, we only have vital statistics and indirect methods applied to population censuses. Furthermore, we only have microdata from birth registrations from 1985 onward, making it impossible to estimate births registered up to 4 or 7 years of age for generations prior to the 1985 cohort. And in vital statistics prior to 1985, the problems inherent in late registration, multiple registration, and omission become increasingly severe the further back in time we go, especially in states where the lack of civil registry offices was more common.

	Table 7.5.	Global rates	selected initial fertility levels,		1990-2015	
Federal entity	1990	1995	2000	2005	2010	2015
Aguascalientes	4.19	3.67	3.28	2.89	2.50	2.20
Baja California	3.54	3.00	2.76	2.53	2.30	2.05
Baja California	3.30	2.88	2.68	2.48	2.28	2.22
Campeche	4.02	3.31	2.97	2.64	2.31	2.20
Coahuila	3.43	3.06	2.90	2.73	2.57	2.50
Colima	3.40	3.12	2.85	2.57	2.30	2.18
Chiapas	4.79	3.90	3.58	3.27	2.95	2.84
Chihuahua	3.55	3.11	2.89	2.67	2.45	2.20
Mexico City	2.47	2.17	2.01	1.84	1.68	1.50
Durango	4.48	3.72	3.35	2.97	2.60	2.35
Guanajuato	4.26	3.57	3.23	2.89	2.55	2.30
Warrior	4.76	4.09	3.68	3.26	2.85	2.50
Gentleman	3.72	3.53	3.14	2.76	2.38	2.20
Jalisco	4.47	3.55	3.23	2.92	2.60	2.25
Mexico	3.63	2.95	2.70	2.45	2.20	2.00
Michoacán	4.77	3.89	3.43	2.96	2.50	2.40
Morelos	3.26	3.20	2.86	2.53	2.20	2.10
Nayarit	4.01	3.38	3.15	2.93	2.70	2.40
Nuevo León	2.79	2.75	2.59	2.44	2.28	2.11
Oaxaca	4.86	3.80	3.36	2.93	2.50	2.30
Puebla	4.66	4.11	3.57	3.04	2.50	2.28
Querétaro	4.54	3.43	3.05	2.68	2.30	2.12
Quintana Roo	4.10	3.57	3.16	2.76	2.35	2.11
San Luis Potosí	4.50	3.97	3.48	2.99	2.50	2.25
Sinaloa	3.34	3.20	2.90	2.60	2.30	2.13
Sonora	3.18	3.20	2.92	2.66	2.40	2.14
Tabasco	3.85	3.36	3.01	2.65	2.29	2.23
Tamaulipas	3.20	2.99	2.78	2.57	2.36	2.30
Tlaxcala	4.04	3.59	3.18	2.78	2.37	2.19
Veracruz	3.60	3.21	2.91	2.60	2.30	2.15
Yucatán	4.21	3.39	2.97	2.56	2.14	1.97
Zacatecas	4.70	3.76	3.41	3.05	2.70	2.51

Source: Selection based on tables 7.1, 7.2, 7.3 and 7.4.

Figure 7.3. Total fertility rates for four selected states, 1970-2015



Source: Table 7.6.

While one alternative would be to restrict the time window to the period 1990-2015, we chose to extend it to 1970 because it offers the advantage of providing more information to establish hypotheses about the future behavior of the phenomenon in the eventual development of population projections.

From a previous work (Mier y Terán and Partida, 2001), we have plausible estimates of the age-specific rates for the natural five-year periods from 1965 to 1990, an interval that allows us to complete the predetermined period.

So far, we only have eleven point observations, and we need ^{them} for each of the 46 years. The annual estimate is described below.

Within each five-year period (or the three-year period 1987-1990), we linearly interpolated—with respect to time—each of the fertility rates by age and state independently. Once the rates for each year were obtained, multiplying them by the female population halfway through Chapter 6 yielded an initial estimate of births. The sum of these estimates across the seven five-year groups gave us the total number of births in each state. Overlaying this state distribution onto the national total from the demographic reconciliation in Chapter 5 yielded the total number of births in each state, consistent with the national total.

For each calendar year, consider a bivariate arrangement, where the rows are the seven five-year age groups of childbearing age, and the columns correspond to the states. From the national reconciliation in Chapter 5, we have the marginals by row,

² The five lustrums of the period 1965-1990 and the estimates for the five-year multiples of 1990-2015 (Table 7.3).

nominally the total number of births in each fertile age group that occurred in the country. We also have the marginals by column, since they correspond to the total estimated in the previous paragraph.

Once we have the two types of marginals, using the iterative biproportional allocation procedure (see Appendix A), we obtain the cells of the array, that is, the births for each five-year age group of reproductive age and federal entity for each particular year. The initial array, to begin the iterative biproportional allocation process, is the first birth estimate mentioned above.

The births resulting from the iterative process are the final estimate, and the quotient obtained by dividing them by the female population in Chapter 6 yields the final age-specific fertility rates. Table 7.6 presents the overall fertility rates for ten years divided into five-year periods, and Figure 7.3 shows the trend for the four states, reflecting four different rates of fertility decline.

Federal entity	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Aguascalientes	7.01	6.32	5.26	4.34	3.79	3.37	2.94	2.67	2.43	2.20
Baja California	5.50	4.64	3.66	3.06	3.21	2.76	2.49	2.35	2.25	2.06
Baja California Sur	5.87	5.04	4.03	3.36	3.00	2.65	2.42	2.30	2.23	2.23
Campeche	6.51	5.77	4.74	4.11	3.65	3.04	2.67	2.44	2.26	2.20
Coahuila	6.01	5.19	4.17	3.52	3.12	2.82	2.61	2.54	2.51	2.50
Colima	6.46	5.71	4.68	3.77	3.09	2.87	2.56	2.38	2.25	2.19
Chiapas	7.45	6.83	5.74	4.97	4.33	3.58	3.20	3.00	2.85	2.82
Chihuahua	6.05	5.25	4.23	3.55	3.22	2.86	2.60	2.47	2.39	2.20
Mexico City	5.56	4.71	3.73	2.96	2.24	2.00	1.81	1.72	1.65	1.52
Durango	6.98	6.30	5.24	4.45	4.06	3.42	3.00	2.75	2.53	2.35
Guanajuato	7.12	6.46	5.39	4.52	3.85	3.28	2.89	2.67	2.48	2.30
Warrior	7.73	7.14	6.04	5.17	4.31	3.76	3.29	3.00	2.76	2.49
Gentleman	7.20	6.53	5.44	4.41	3.37	3.24	2.82	2.55	2.32	2.21
Jalisco	7.15	6.48	5.41	4.55	4.04	3.26	2.90	2.69	2.53	2.25
Mexico	6.34	5.57	4.53	3.79	3.29	2.72	2.43	2.27	2.15	2.01
Michoacán	7.54	6.91	5.81	4.95	4.31	3.58	3.06	2.73	2.43	2.40
Morelos	6.30	5.55	4.53	3.71	2.96	2.94	2.57	2.35	2.15	2.11
Nayarit	6.84	6.14	5.09	4.25	3.64	3.11	2.83	2.71	2.63	2.40
Nuevo León	5.65	4.81	3.82	3.08	2.53	2.53	2.34	2.26	2.23	2.12
Oaxaca	7.78	7.19	6.07	5.16	4.41	3.49	3.01	2.70	2.43	2.30
Puebla	7.66	7.05	5.95	5.07	4.22	3.77	3.20	2.80	2.43	2.28
Querétaro	7.41	6.78	5.69	4.80	4.11	3.15	2.74	2.47	2.24	2.13
Quintana Roo	6.14	5.36	4.34	3.72	3.71	3.28	2.84	2.55	2.30	2.12
San Luis Potosí	7.58	6.97	5.88	4.92	4.08	3.65	3.12	2.76	2.43	2.25
Sinaloa	6.19	5.40	4.38	3.66	3.03	2.94	2.60	2.41	2.24	2.13
Sonora	5.96	5.14	4.13	3.40	2.89	2.94	2.63	2.47	2.34	2.14
Tabasco	6.70	6.00	4.95	4.12	3.49	3.09	2.69	2.44	2.23	2.24
Tamaulipas	5.91	5.10	4.09	3.35	2.90	2.76	2.50	2.38	2.31	2.31
Tlaxcala	7.13	6.46	5.40	4.54	3.67	3.30	2.85	2.57	2.31	2.20
Veracruz	6.56	5.83	4.79	3.96	3.27	2.96	2.61	2.41	2.24	2.16
Yucatán	6.62	5.87	4.82	4.16	3.82	3.11	2.66	2.36	2.09	1.98
Zacatecas	7.76	7.18	6.07	5.09	4.25	3.46	3.05	2.82	2.63	2.51

Source: Table 7.5 and reconciliation of the state population from chapter 6.

8 State mortality

The problems in the declaration of age and the coverage of deaths for the national aggregate, corrected in chapter 2, worsen at the state level, given the complexity involved in the differences in both irregularities in the federal entities.

Mortality in the first years of life can be estimated using indirect methods, since the small number of deaths recorded in the ENADID pregnancy records prevents a reliable estimate of the phenomenon for the states. For the population aged five and over, however, deaths from vital statistics must be used, which present an additional imprecision: the location of the deceased's residence (numerator of the rate) does not always match the corresponding location in the population censuses (denominator).

Initial estimates of state mortality levels and trends are made for the nine five-year periods from 1970 to 2015. The analysis begins with five-year periods to provide greater numerical representativeness of deaths in vital statistics, especially in states with smaller populations, and to facilitate the application of indirect methods. Once mortality levels are obtained, they are disaggregated annually from 1970 to 2015 using interpolation procedures and the previous estimates of population (Chapter 6) and national deaths (Chapter 5). From the final estimate of deaths, mortality rates and probabilities are derived.

8.1 Early childhood mortality

The problems of underreporting in infant deaths and in the population under three years of age, as well as the low representativeness of pregnancy histories in sample surveys at the state level, leave indirect estimation methods as a viable alternative to obtain the levels of mortality in early childhood in the federal entities.

Indirect estimation methods consist of transforming the proportions of live-born children who have died at the time of the census or count, of women aged 15 to 49 years classified into five-year age intervals (United Nations, 1983); however, there is evidence that before the age of 25 the estimates may be biased, since there is some degree of selectivity in women aged 15 to 24 years (Hill, 1991).

In Chapter 2, we identified that mortality levels derived from information on living children in the 2000 and 2010 censuses overestimate early childhood mortality levels if we accept the data derived from pregnancy histories in the National Survey on Demographic Dynamics (ENADID) and the 1990 census and 2005 count. However, using these data is unavoidable, as otherwise we would lack baseline information for the five 25-year periods. In reality, we only need the state-level differences, since the final estimates will be based on previously established national values. Thus, we assume that the differences between states are adequate in the 2000 and **2010 censuses**.

The most recent versions of indirect methods also allow us to place the levels in dates prior to the census or survey (United Nations, 1983), which allows us to establish them in the nine five-year periods of our interest.

After a detailed inspection of the temporal location of the estimates and the relationship between contiguous dates of occurrence, we selected as initial values: for 1970-1990 the estimates of Gómez de León and Partida (2001); for 1990-1995 those corresponding to women aged 30 to 34 from the 2000 census; for 1995-2000 the average of those derived from the 30-34 and 35-39 age groups from the 2005 count; for 2000-2005 from the 30-34 age interval of the 2010 census; for 2005-2010 from the 25-29 age interval of the 2010 census; for 2010-2015 of 25-29 year olds from the 2015 survey. As in the national case, the Coale and Demeny (1983) West model was chosen for the application of the indirect method.

Let D_{0i} denote the infant deaths occurring in state i in any of the five five-year periods, births occurring, and B to the national values. Let q_{0i} and q_0 be the probabilities of dying in the first year of life in state i and for the country as a whole, respectively. Given that $D_{0i} = B_i q_{0i}$, or $D_0 = B q_0$, and the sum of infant deaths over the 32 federal entities is expected to be equal to the national total, we have:

$$D_0 = \sum_{i=1}^{32} D_{0i} = \sum_{i=1}^{32} B_i q_{0i}$$

and the national infant mortality rate is:

$$q_0 = \frac{D_0}{B} = \frac{\sum_{i=1}^{32} B_i q_{0i}}{B} = \sum_{i=1}^{32} \left(\frac{B_i}{B} \right) q_{0i} = \sum_{i=1}^{32} w_i q_{0i} \quad (8.1)$$

because national births do not mathematically depend on the subscript i and therefore act as a scalar under the summation, and w_i is the state distribution of the total

births in the country, which is obtained from the fertility and birth rate estimates in Chapter 7.

The indirect estimates 5 or do not satisfy (8.1), but if we assume that they preserve the true relationship between the federative entities, we can incorporate a correction factor

$$Q_{0,ik} q_{0,i}$$

(8 . 2)

that when introduced in (8.1):

$$g_o = \sum_{i=1}^{32} W_i k q_{oi}$$

and clear:

$$k = \frac{g_o}{\sum_{i=1}^{32} W_i} \quad (8.3)$$

It is worth asking whether infant mortality rates estimated using the indirect method truly reflect the standard of living in the states, since, before reaching their first birthday, the living conditions in which an infant develops are crucial for their survival. To examine this relationship, we constructed a well-being index that encompasses infrastructure conditions in the territorial units, access to education, and household consumption potential, the latter measured by wages.

Access to education was measured by the percentage of children and adolescents aged 6 to 14 who attend school and the proportion of people aged 15 and over with completed primary education or higher. Optimal material living conditions are defined, on the one hand, by decent housing and, on the other, by sufficient monetary resources to cover expenses for food, clothing, transportation, education, health, and recreation. Indicators of adequate housing included: the percentage of occupants in private dwellings with sturdy walls (adobe, partition, brick, block, stone, quarry stone, cement, or concrete), with floors other than dirt, without overcrowding (two or fewer people per bedroom), with piped water on the property, with sanitation facilities, with drainage, and with electricity.

It was considered that three minimum wages, as compensation for labor, were sufficient to satisfy the material demands for a decent standard of living in 2000. This threshold was set according to the following reasoning. Based on information from the 2000 census and a statistical model of determinants, the households surveyed were classified according to whether or not they exceeded the asset poverty line established by SEDESOL (2002: 9), which determines the ability to cover family expenses for food, clothing, transportation, education, health, and recreation. In households living in poverty, the average compensation for the economically active employed population was 2.6 minimum wages; in families that did not experience deprivation, it was 4.1 minimum wages; thus, 3 was established as the number of minimum wages required to satisfy the material needs of the population.

The variables used were captured in four of the five population censuses employed here (1970, 1990, 2000, and 2010), the 2005 census, and the 2015 Intercensal Survey, and are comparable over time—except for slight modifications. However,

To make wages comparable, it is necessary to convert them to constant prices, for which we take 2000 as the base year: given that the National Consumer Price Index increased 5.6 times from March 1990 to February 2000, the purchasing power of 3 minimum wages in 2000 is equivalent to 2 minimum wages in 1990, and under similar reasoning, to one minimum wage in 1970 and three in 2005, 2010 and 2015; thus, we take as an indicator the employed population that earned those minimum wages on each date of population enumeration.¹

As a summary measure, the arithmetic mean of these eleven percentages was used, since they are considered equally important. The simple arithmetic mean offers two analytical advantages: first, it assigns equal weight to all characteristics, which is consistent with the fact that they are all equally important; second, it maintains consistency across time and space because the scale is the same. In the table 8.1 The indices are presented for the years taken into account and their linear interpolation, with respect to time, for the nine five-year periods considered.

In order to have a direct association with the probability of dying in early childhood, we take the complement to unity, which we will call the deprivation index .

Figure 8.1 shows the relationship between the deprivation index and the infant mortality rate calculated using equations (8.2) and (8.3). Although the pattern is as expected, in terms of the direct association between deprivation and the risk of death in the first year of life, several states deviate from the linear trend. To achieve greater consistency between deprivation levels and infant mortality, a robust linear regression was calculated using the 32 observations. The procedure is illustrated in Figure 8.1 with the five-year period 1995–2000; the solid line represents the robust regression fit. States falling within the 90 % confidence interval (dashed lines) were retained, while those outside were assigned to the nearest interval limit. In the five-year period under consideration, for example, the probability of dying in Puebla (PU) was assigned the upper limit, while Nuevo León (NL) was assigned the lower limit. The selected values were then applied to the national total using equations (8.2) and (8.3); the results are shown in Table 8.2. The breakdown by sex was performed using the differential of the Coale and Demeny (1983) West model. The resulting values were then applied to the national totals by sex using equations (2.2) and (2.3').

The first estimate of the probability of preschool mortality was obtained as that associated with infant mortality (*qo*) under the Western model. The number of survivors at the exact age of one for each federal entity, in the absence of any migration, is:

$$= Bi(1 - qoj)$$

and its state distribution is:

¹ The 2005 count did not capture economic variables; we took the labor perceptions from the four quarters of the National Survey of Occupation and Employment.

² Robust regressions for the entire chapter were performed using the STATA *rreg* command (2003).

Federal entity	1970	1990	2000	2005	2010	2015	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
Mexican Republic	0.4933	0.65	0.70	0.82	0.82	0.7	0.51	0.55	0.59	0.63	0.66	0.69	0.76	0.82	0.79
Aguascalientes	0.5650	15	98	26	33	642	31	26	22	17	61	52	62	30	37
		0.74	0.78	0.87	0.87	0.7	0.58	0.63	0.67	0.72	0.75	0.77	0.82	0.87	0.83
		36	20	06	02	916	74	20	66	13	32	24	63	04	09
Baja California	0.5933	0.70	0.74	0.88	0.86	0.8	0.60	0.63	0.66	0.68	0.71	0.73	0.81	0.87	0.84
		34	90	90	08	250	71	46	21	97	48	76	90	49	29
Baja California Sur	0.4607	0.69	0.73	0.86	0.86	0.8	0.49	0.54	0.60	0.66	0.70	0.72	0.80	0.86	0.83
		86	87	28	42	111	04	99	94	89	86	86	07	35	77
Campeche	0.4008	0.58	0.64	0.79	0.78	0.7	0.42	0.46	0.51	0.56	0.59	0.63	0.71	0.78	0.75
		33	72	10	57	287	36	92	49	05	93	13	91	83	72
Coahuila	0.5755	0.72	0.76	0.87	0.86	0.8	0.59	0.63	0.66	0.70	0.73	0.75	0.82	0.87	0.83
		24	97	94	61	085	39	06	73	41	42	79	45	28	73
Colima	0.4881	0.72	0.76	0.86	0.86	0.8	0.51	0.57	0.63	0.69	0.73	0.75	0.81	0.86	0.83
		53	20	82	30	032	78	71	64	57	45	28	51	56	31
Chiapas	0.2840	0.47	0.59	0.70	0.70	0.6	0.30	0.35	0.40	0.45	0.50	0.56	0.64	0.70	0.68
		88	12	42	80	656	84	71	58	45	69	31	77	61	68
Chihuahua	0.5641	0.70	0.75	0.85	0.85	0.8	0.58	0.61	0.65	0.69	0.72	0.74	0.80	0.85	0.84
		79	88	77	24	297	21	87	40	00	06	61	82	50	11
Mexico City	0.7595	0.76	0.78	0.89	0.89	0.8	0.76	0.76	0.76	0.76	0.77	0.78	0.84	0.89	0.89
		85	93	66	68	832	06	29	51	74	37	41	29	67	00
Durango	0.4492	0.64	0.71	0.82	0.82	0.7	0.47	0.52	0.57	0.62	0.66	0.70	0.77	0.82	0.78
		81	86	48	23	564	41	38	35	32	57	10	17	35	94
Guanajuato	0.4467	0.66	0.72	0.81	0.82	0.7	0.47	0.52	0.58	0.63	0.67	0.71	0.77	0.81	0.79
Warrior	0.3275	44	54	51	37	593	39	83	28	72	97	02	03	94	15
		0.50	0.57	0.68	0.70	0.6	0.35	0.39	0.44	0.48	0.52	0.56	0.62	0.69	0.68
		96	84	06	18	705	03	58	13	68	68	12	95	12	62
Gentleman	0.3698	0.56	0.67	0.79	0.80	0.7	0.39	0.44	0.49	0.54	0.59	0.64	0.73	0.79	0.77
Jalisco	0.5501	71	22	51	28	472	44	38	31	24	34	59	37	90	50
		0.73	0.76	0.85	0.86	0.7	0.57	0.61	0.66	0.70	0.73	0.75	0.80	0.86	0.83
		03	29	30	73	970	26	77	27	78	85	48	80	02	22
Mexico	0.5137	0.69	0.73	0.84	0.84	0.7	0.53	0.58	0.62	0.67	0.70	0.72	0.79	0.84	0.81
Michoacán	0.4035	75	99	56	79	837	67	26	85	45	81	93	27	67	58
		0.63	0.69	0.79	0.79	0.7	0.43	0.49	0.54	0.60	0.65	0.68	0.74	0.79	0.76
		52	83	98	58	341	24	04	83	63	10	25	90	78	49
Morelos	0.4877	0.68	0.72	0.82	0.83	0.7	0.51	0.56	0.61	0.66	0.69	0.71	0.77	0.83	0.80
		52	61	57	58	687	24	18	12	05	54	59	59	07	22
Nayarit	0.4219	0.68	0.72	0.83	0.83	0.7	0.45	0.51	0.58	0.65	0.69	0.71	0.77	0.83	0.79
Nuevo León	0.6292	27	54	07	44	572	45	97	49	01	34	48	81	25	58
		0.74	0.78	0.89	0.89	0.8	0.64	0.67	0.70	0.73	0.75	0.77	0.83	0.89	0.87
		53	00	69	00	661	37	27	17	07	39	13	85	34	80
Oaxaca	0.2856	0.49	0.59	0.70	0.71	0.7	0.31	0.36	0.41	0.47	0.52	0.56	0.64	0.71	0.71
		66	07	41	82	121	20	47	75	02	01	72	74	12	52
Puebla	0.4068	0.58	0.66	0.78	0.78	0.7	0.42	0.47	0.51	0.56	0.60	0.64	0.72	0.78	0.76
		46	42	18	45	362	90	35	79	24	45	43	30	32	03
Querétaro	0.4021	0.64	0.72	0.82	0.84	0.7	0.43	0.49	0.55	0.61	0.66	0.70	0.77	0.83	0.81
		80	43	45	82	873	29	43	58	73	71	52	44	63	77
Quintana Roo	0.3276	0.62	0.71	0.85	0.83	0.7	0.36	0.44	0.51	0.59	0.64	0.68	0.78	0.84	0.80
		82	00	12	70	658	52	03	55	06	87	95	76	41	14
San Luis Potosí	0.3873	0.59	0.66	0.78	0.79	0.7	0.41	0.46	0.51	0.56	0.61	0.64	0.72	0.79	0.76
		09	74	79	28	365	28	37	46	54	00	83	76	04	47
Sinaloa	0.4339	0.66	0.71	0.83	0.83	0.7	0.46	0.51	0.57	0.63	0.67	0.70	0.77	0.83	0.80
		07	49	68	54	668	22	89	56	23	43	14	59	61	11
Sonora	0.5550	0.70	0.73	0.85	0.85	0.8	0.57	0.61	0.64	0.68	0.71	0.72	0.79	0.85	0.83
		49	63	68	10	145	37	12	87	62	28	85	66	39	28
Tabasco	0.3237	0.61	0.68	0.81	0.80	0.7	0.36	0.43	0.50	0.58	0.63	0.66	0.74	0.80	0.77
		67	40	55	29	540	03	36	68	01	35	71	97	92	84
Tamaulipas	0.5137	0.66	0.72	0.84	0.83	0.7	0.53	0.56	0.60	0.64	0.67	0.70	0.78	0.84	0.81
		00	08	77	87	997	20	86	51	17	52	56	43	32	92
Tlaxcala	0.4479	0.65	0.72	0.83	0.83	0.7	0.47	0.52	0.57	0.62	0.67	0.70	0.77	0.83	0.79
		55	11	53	20	617	39	58	77	95	19	47	82	36	68
Veracruz	0.3915	0.55	0.63	0.75	0.76	0.7	0.41	0.45	0.49	0.53	0.57	0.61	0.69	0.76	0.73
		06	15	91	39	099	14	11	09	07	08	12	53	15	69
Yucatán	0.3889	0.61	0.67	0.78	0.79	0.7	0.41	0.47	0.52	0.58	0.62	0.66	0.72	0.78	0.76
Zacatecas	0.3842	01	73	08	03	314	65	18	71	24	69	05	91	55	08
		0.62	0.71	0.81	0.82	0.7	0.41	0.47	0.53	0.59	0.64	0.69	0.76	0.81	0.79
		48	61	01	54	603	43	44	46	47	76	33	31	77	29

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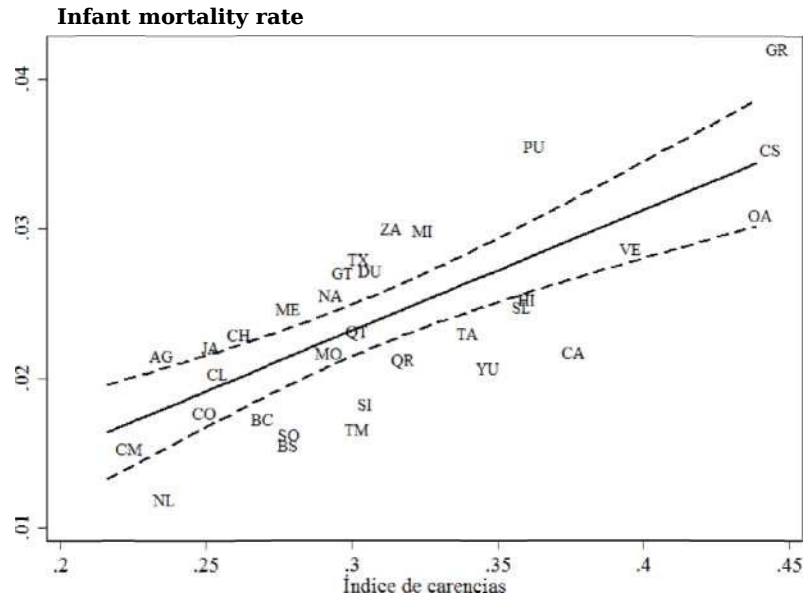
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Source: Population censuses and counts 1970 to 2010 and intercensal survey 2015.

Federal entity	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
Mexican Republic	68.76	60.39	47.68	37.34	29.71	25.01	20.14	17.15	15.16
Aguascalientes	60.21	48.06	35.04	28.80	24.08	21.48	16.47	16.48	14.23
Baja California	52.55	45.19	34.68	29.72	22.08	18.91	15.78	17.20	13.13
Baja California Sur	68.62	57.61	42.37	31.92	22.50	19.83	17.65	12:30	12.95
Campeche	77.02	68.48	55.13	42.66	28.32	27.59	21.41	14.69	14.97
Coahuila	57.27	49.19	36.57	28.87	27.81	16.93	16.07	16.71	14.10
Colima	65.15	57.08	41.58	31.17	31.88	19.44	14.85	12.21	13.12
Chiapas	94.47	86.90	73.19	55.23	46.00	33.82	24.06	24.51	18.63
Chihuahua	59.89	51.85	39.34	30.58	25.39	23.09	20.34	14.89	14.62
Mexico City	38.48	32.80	24.14	22.79	26.00	14.62	15.48	14.18	14.91
Durango	70.74	61.25	47.39	36.91	27.99	26.31	21.74	15.67	15.54
Guanajuato	73.96	62.93	48.62	36.74	27.26	25.58	21.81	19.08	14.69
Warrior	87.01	80.24	66.98	50.61	37.41	40.95	30.61	21.37	20.17
Gentleman	84.82	75.74	61.43	46.32	37.76	26.66	18.12	18.31	14.71
Jalisco	60.83	51.90	38.24	30.04	31.13	22.54	16.57	17.70	13.91
Mexico	62.88	52.90	39.61	31.33	25.93	24.20	20.89	15.07	15.68
Michoacán	77.32	68.91	53.41	39.85	28.82	27.90	22.86	20.29	15.18
Morelos	66.36	58.54	44.84	33.83	32.32	20.75	16.90	13.57	14.12
Nayarit	73.22	64.77	48.34	35.49	26.59	25.24	16.55	13.51	14.29
Nuevo León	48.49	41.36	30.49	25.81	19.34	15.27	15.25	14.01	11.36
Oaxaca	96.50	87.63	72.73	53.65	42.90	29.66	23.48	15.91	15.37
Puebla	80.04	71.36	57.78	43.67	31.82	31.69	24.38	17.14	17.19
Querétaro	79.52	67.26	51.19	38.65	34.28	22.20	19.14	17.02	13.66
Quintana Roo	83.95	72.17	55.05	39.81	26.07	23.47	16.89	17.68	14.14
San Luis Potosí	79.38	69.58	55.68	42.87	35.96	26.51	18.83	18.96	14.87
Sinaloa	72.25	62.37	49.16	36.55	24.67	22.45	19.06	13.38	14.15
Sonora	57.53	51.21	39.07	30.39	22.22	19.85	17.90	16.40	13.76
Tabasco	84.52	75.36	59.23	42.29	26.82	25.21	20.29	17.74	14.65
Tamaulipas	63.05	54.94	42.98	34.75	24.62	22.07	18.61	16.74	14.22
Tlaxcala	74.07	63.93	49.32	37.50	27.66	26.01	21.46	15.38	16.07
Veracruz	78.50	70.80	58.73	45.43	29.45	27.43	19.32	19.35	15.18
Yucatán	77.88	68.15	53.55	40.59	27.12	25.68	21.07	14.75	14.92
Zacatecas	81.84	71.22	55.37	41.04	29.02	26.95	22.14	15.85	16.17

Source: Population censuses and counts 1970 to 2010 and 2015 survey and births from chapter 7.

Figure 8.1. Relationship between mortality rate and deprivation in the states, 1995-2000



Note: See Annex C for the meaning of the acronyms. **Source:** XII General Population

$$w_u = \frac{\text{Neither, } Bi(1 - q_{0,i})}{32} - \frac{Wi(1 - q_{0,i})}{32}$$

$$3 = 1 \quad \text{And } Bi \sim q_{0,i} \quad 3 = i \quad w_i(1 - \ll M)$$

where the second equality is obtained by dividing the numerator and denominator by the national number of births. The factor $4k$ is, by analogy with (8.3):

$$4*1 = \text{-----}(8-3')$$

$$3 = 1$$

with $4qf$ the value obtained under the West model. The final probability is:

$$491, i = 4*1 \quad 4qf \quad (8.4)$$

The procedure was performed for each sex separately. The probability for the combination of the sexes is obtained with formula (2.4). The results are reproduced in Table 8.3

Federal entity	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
Mexican Republic	28.44	18.57	12.59	9.08	6.20	4.15	3.24	2.85	2.58
Aguascalientes	24.77	14.48	8.92	6.64	4.69	3.27	2.40	2.46	2.15
Baja California	21.62	13.61	8.83	6.85	4.30	2.88	2.30	2.56	1.98
Baja California Sur	28.23	17.36	10.79	7.36	4.38	3.02	2.57	1.83	1.95
Campeche	31.69	20.63	14.04	9.84	5.51	4.20	3.12	2.19	2.26
Coahuila	23.56	14.82	9.31	6.66	5.41	2.58	2.34	2.49	2.13
Colima	26.81	17.20	10.59	7.19	6.21	2.96	2.16	1.82	1.98
Chiapas	38.87	26.18	18.65	12.75	8.96	5.16	3.51	3.66	2.82
Chihuahua	24.64	15.62	10.02	7.05	4.94	3.52	2.96	2.22	2.21
Mexico City	15.83	9.88	6.15	5.25	5.06	2.22	2.25	2.11	2.25
Durango	29.11	18.45	12.07	8.51	5.45	4.01	3.17	2.34	2.35
Guanajuato	30.43	18.96	12.39	8.48	5.31	3.90	3.18	2.85	2.22
Warrior	35.80	24.18	17.07	11.68	7.29	6.25	4.47	3.19	3.05
Gentleman	34.90	22.82	15.65	10.69	7.35	4.06	2.64	2.73	2.22
Jalisco	25.03	15.63	9.74	6.93	6.06	3.43	2.41	2.64	2.10
Mexico	25.87	15.94	10.09	7.23	5.05	3.69	3.04	2.25	2.37
Michoacán	31.81	20.76	13.61	9.19	5.61	4.25	3.33	3.03	2.29
Morelos	27.30	17.64	11.42	7.80	6.29	3.16	2.46	2.02	2.13
Nayarit	30.13	19.51	12.31	8.19	5.18	3.84	2.41	2.01	2.16
Nuevo León	19.95	12.46	7.76	5.95	3.76	2.32	2.22	2.09	1.71
Oaxaca	39.71	26.40	18.53	12.38	8.36	4.52	3.42	2.37	2.32
Puebla	32.93	21.50	14.72	10.08	6.20	4.83	3.55	2.56	2.60
Querétaro	32.72	20.26	13.04	8.92	6.68	3.38	2.79	2.54	2.06
Quintana Roo	34.54	21.74	14.02	9.18	5.07	3.58	2.46	2.64	2.13
San Luis Potosí	32.66	20.96	14.19	9.89	7.00	4.04	2.74	2.83	2.24
Sinaloa	29.73	18.79	12.52	8.43	4.80	3.42	2.78	1.99	2.14
Sonora	23.67	15.43	9.95	7.01	4.32	3.02	2.61	2.45	2.08
Tabasco	34.78	22.70	15.09	9.76	5.22	3.84	2.96	2.65	2.21
Tamaulipas	25.94	16.55	10.95	8.01	4.79	3.36	2.71	2.50	2.15
Tlaxcala	30.47	19.26	12.56	8.65	5.38	3.96	3.13	2.29	2.43
Veracruz	32.30	21.33	14.96	10.48	5.73	4.18	2.81	2.89	2.29
Yucatán	32.04	20.53	13.64	9.37	5.28	3.91	3.07	2.20	2.25
Zacatecas	33.68	21.46	14.11	9.47	5.65	4.11	3.23	2.36	2.44

Source: Population censuses and counts 1970 to 2010 and 2015 survey and births from chapter 7.

8.2 Mortality of five years of age or older

The estimate for those over five years of age is based on specific mortality rates by five-year age groups.

$${}_5M_x = \frac{{}_5bD_x}{{}_5bK_x} \quad (8-5)$$

where ${}_5M_x$ is the mortality rate in the semi-open interval of exact ages $[x, x + 5)$ for any of our nine lustrums of interest, ${}_5bD_x$ the registered deaths and ${}_5bK_x$ person-years lived.

Each of the nine five-year periods runs from the middle of the first year to the middle of the last year. Because we do not have data on deaths broken down by month of occurrence, we will assume that they are evenly distributed within each calendar year. Thus, for a specific five-year period, the total is the sum of half the deaths recorded in the first and last years of the period, plus the sum of the deaths in the four intervening years. For example, for the period 2000–2005, half the deaths recorded in 2000 and 2005 are added together, along with the sum of those recorded from 2001 to 2004.

Calculating person-years is simpler. Let's consider, for example, the same period 2000–2005. The first year of the five-year period runs from mid-2000 to mid-2001, and the average population for that year corresponds to January 1, 2001. Clearly, for the five-year period, the person-years lived are the sum of the populations at the beginning of each year from 2001 to 2005. The same reasoning applies to the other three five-year periods. The populations on January 1 of each year were estimated in Chapter 6.

The rates calculated using (8.5) are a good approximation of mortality if death registration coverage were similar in all 32 states; however, such similarity is not the case. The 1992 and 1997 National Surveys on Demographic Dynamics (ENADID) included a module asking whether any household member had died during the previous five-year period. If the answer was yes, respondents were asked about the sex and age of those who had died and whether the death had been registered. The ENADID distributions refer to the periods 1987–1992 and 1992–1997; given their temporal proximity, we have equated them to the five-year periods 1990–1995 and 1995–2000. We consider deaths of individuals one year of age or older because, as stated in Chapter 2, there is evidence that civil registry death coverage is similar in that age range. Likewise, we sampled both sexes together to have greater accuracy in the ENADID samples.

The data are reproduced in Table 8.4. In the first five years, Chiapas, Chihuahua, Durango, Nayarit, and Oaxaca stand out with more than 10% omission, while in the second five-year period, Durango stands out with 14%. Guerrero deserves special mention, with more than 18% in the first period and, especially, almost 25% in the second. Given this scenario, it should not be surprising that in some years Guerrero is the state with the highest life expectancy if the mortality table is calculated directly using vital statistics and population enumerations.

Unfortunately, the mortality module was not included in the 2006, 2009, and 2014

Federal entity	Occurred (Yo)	Registered (2)	Omission (3) = 1 - (2)/(1)	Occurred (4)	Registered (5)	Factor $\gamma_{\text{reg}} = \frac{5}{5}$
Total	1 852 341	1,771,272	0.0438	2 113 464	2,024,472	0.0421
Aguascalientes	13,120	12,943	0.0135	17,670	17 179	0.0278
Baja California	28,734	28,366	0.0128	48 061	45,975	0.0434
Baja California Sur	5,366	5 239	0.0237	6 277	6 234	0.0069
Campeche	10,568	10,452	0.0110	14,538	14,028	0.0351
Coahuila	42,780	41,896	0.0207	50 186	47,372	0.0561
Colima	10,524	10,279	0.0233	10,408	10 201	0.0199
Chiapas	54,673	45,819	0.1619	69 021	62,818	0.0899
Chihuahua	54 198	48 025	0.1139	60,480	57,969	0.0415
Mexico City	213 542	210 659	0.0135	197,086	194,311	0.0141
Durango	32,055	27,579	0.1396	33 168	28,504	0.1406
Guanajuato	85,750	85 220	0.0062	110,470	109,354	0.0101
Warrior	68 653	56,624	0.1752	96 390	72,614	0.2467
Gentleman	54,640	50 808	0.0701	57,464	54,471	0.0521
Jalisco	116 078	115,337	0.0064	126,962	123 918	0.0240
Mexico	223 576	223 055	0.0023	270 953	270 953	
Michoacán	89 164	84 127	0.0565	87 808	82,979	0.0550
Morelos	28,467	27,662	0.0283	34,456	33,712	0.0216
Nayarit	18,609	16,414	0.1180	22,410	20,813	0.0713
Nuevo León	59,194	57,773	0.0240	62,972	60,684	0.0363
Oaxaca	79,310	70 706	0.1085	88 655	83,459	0.0586
Puebla	105 144	103 708	0.0137	123,977	120,680	0.0266
Querétaro	19,762	19,462	0.0152	23,883	23,390	0.0206
Quintana Roo	6085	5,792	0.0482	7712	7,426	0.0371
San Luis Potosí	46,648	45 205	0.0309	47,471	44 163	0.0697
Sinaloa	41 403	39 117	0.0552	48,856	47,411	0.0296
Sonora	45,495	44 891	0.0133	50,798	48,411	0.0470
Tabasco	29,428	28,533	0.0304	30 841	30,537	0.0099
Tamaulipas	50 300	48,697	0.0319	59 801	56,406	0.0568
Tlaxcala	15,984	15,968	0.0010	21,679	21,417	0.0121
Veracruz	145,404	134,426	0.0755	166,345	162 129	0.0253
Yucatán	32 283	31 263	0.0316	39,851	39,527	0.0081
Zacatecas	25,404	25 227	0.0070	26,815	25,427	0.0518

Source: National Survey of Demographic Dynamics 1992 and 1997.

It is a well-known fact that as living conditions improve, the overall mortality rate decreases, or life expectancy increases. To diagnose the link between these two variables, we selected:

1. Life expectancy at 5 years as a summary indicator of mortality from that age onwards.
2. The well-being index (Table 8.1) to have a direct association with life expectancy.

Before examining the link between standard of living and survival, it is necessary to ensure that state mortality rates align with the previously established national mortality rate. To achieve this alignment, we employ the concept of entropy. Let us assume that the instantaneous mortality rate $\mu(x)$ changes proportionally and equally at all ages:

that is, $i^*(x) = [1 + 5] / i(x)$. Keyfitz (1985: 24) shows that the proportional change in life expectancy at age x is:

$$\frac{\Delta e^*}{e^*} = \frac{H(x)}{e^*} \quad (8.6)$$

where H is the entropy of the life table, whose value is given by;

$$H(x) = - \int_0^{e^*(x)} p_x(y) \ln \{p_x(y)\} dy$$

$p_x(y)$ is the probability of surviving from exact age x to exact age $x + y$, that is, $p_x(y) = l_{x+y}/l_x$, with l_x the survivors of the life table at the exact age x .

Entropy tells us by what proportion life expectancy increases for a proportional decrease **equal** for all ages (or decreases if there is an increase). The entropy value was obtained as follows. It is clear that the denominator of (8.7) is the life expectancy at age x , according to equations (D.15) and (D.16) in Appendix D:

$$e^*(x) = \frac{\sum_{y=0}^{e^*(x)-1} {}_nL_y}{l_x} \quad (8.8)$$

where ${}_nL_y$ are the person-years lived by the cohort in the table between the exact ages y and $y + n$, and the index of the summation increases by n . **One** way to calculate person-years is formula (D.4'):

$${}_nL_y = \frac{{}_nPy_y + {}_{n-1}Py_{y+1} + \dots + {}_1Py_{y+n-1} + {}_0Py_{y+n}}{2} \quad (^*)$$

where ${}_nPy_y$ are the person-years lived between the exact ages y and $y + n$ are the deaths occurring in that age interval. If we let $ypp_x = p_x(y) \ln \{p_x(y)\}$ and adopt the values of ${}_nPy_y$ for that function, by similarity with (8.9) we have:

$$H(x) = - \int_0^{e^*(x)} p_x(y) \ln \{p_x(y)\} dy = - \sum_{y=x}^{e^*(x)} ypp_x$$

Let us take as a comparative standard the national mortality, that is, the rates $p(x)$ and its 5-year age entropy $H(5)$, and let us say that the mortality of the federal

i deviates from the national level by the proportional factor 4^* , that is, $i(x) = [1 + 5^*] i(x)$. With the 5-year life expectancy e_1 calculated with the initial rates, the national one obtained from the estimates in Chapter 2 and its entropy, by solving in (8.6) we have that factor:

$$\frac{Ci_{-5} - e_5}{H(5)e_5} \quad (8.11)$$

One would expect the average of those factors to be:

$$S = \frac{1}{32} \quad (8.12)$$

would be equal to zero, since the national mortality rate is an average of the total mortality rates. Since this is not the case, let's do the following:

$$\hat{\sigma}_i - \bar{\sigma}$$

whose sum, and therefore average, equals zero. While these new factors satisfy the national mortality rate

$$\sum_{i=1}^{32} 1^{i+} = M^x$$

It is worth asking whether, based on principle (6.1) of Chapter 6, the factors should not be weighted by the spatial distribution of the population (person-years lived). It is not necessary. In previous exercises, once **5 was obtained**, the new life expectancy was estimated by solving in (8.6) as:

$$= e_5 \frac{1 - H(5)S}{5} \quad (8.13)$$

and with it and the original state values a new factor was obtained, according to (8.6)

$$6 = \text{visit} \quad (8.14)$$

The original rates were modified as ${}_5M^* = \frac{1}{1 + 5}$ they overcame the populations were aggregated by age and across the 32 federal entities. The total number of deaths obtained in this way barely differed from the known national total.

We will exemplify the procedure, the same for all nine five-year periods, with the five-year period 1995-2000. Because in some five-year periods and some states differences were observed in life expectancies, greater than 5 years and less than 1 year between the sexes, we prefer to start with the total population, and once the final estimates are obtained, separate them into men and women.

If we give credit to the omission captured in the **ENADID** for 1992-1997, we begin by assimilating the omission (column 6 of table 8.4) to δ' . The resulting expectations

Applying (8.13), with the observed values and entropies specific to the federal entity, are included in Table 8.5. Once these initial expectations are obtained, we “normalize” them to the national total, valuing (8.14), (8.12), and (8.12'), and we call them “initial.” Along with the

Values of *or* are shown in Table 8.5.

In order to have a comparative standard, we constructed a straight line, taking the well-being index as the independent variable and life expectancy at age 5 as the dependent variable. We assumed that the difference in *e* between the extreme values of the well-being index would be 4 years, so the slope of the line is:

$$\beta = \frac{4}{IB_{\max} - IB_{\min}}$$

and the y-intercept, based on the arithmetic mean of the observed expectations and the well-being indices:

$$a = e_5 - \beta IB$$

The idea is that the life expectancies estimated with the line $e = a + \beta IB$ would be the expected behavior of life expectancy if the dispersion were given by the straight line. We continue the procedure, taking the arithmetic mean of these theoretical and initial life expectancies. The results are shown in the last columns of Table 8.5.

We continued the estimation by fitting a robust regression based on the well-being index. The adjusted expected values were normalized to the national total, and, maintaining the coefficient of variation of the estimators (standard error divided by the predicted expected value), we superimposed it onto the **normalized expected value**. With these new standard errors, we generated the 90% confidence interval for the estimate. The results are reproduced in Table 8.6 and Figure 8.2 in the upper panel. Note that the few initial expected values fall within the confidence interval. As with early childhood mortality, states that fell within the 90% confidence interval were retained, while those that fell outside were assigned to the nearest interval boundary. Let's say this is the first attempt.

With the selected expectations, the robust regression was re-estimated in a second attempt. The selected values are shown in the lower panel of Figure 8.2. Note that the confidence interval narrowed, and the chosen values, which we consider definitive, are very close to the regression line.

We continue with the five-year period 1990–1995, adopting the omission of the 1992 ENADID survey for the five-year period. We repeat the exercise and also need two attempts.

For the remaining seven five-year periods, as mentioned above, we do not have figures for underreporting of deaths, as we do for the ENADID surveys of 1992 and 1997. We began replicating the exercise with the final underreporting factors, calculated using (8.11) incorporating expected values and observed entropies from the immediately preceding or following five-year period, as applicable; that is, with the final **SI** values for 1990–1995 we began the five-year period 1985–1990, with the final values for this period we began 1980–1985, and so on until we finished in 1970–1975. Likewise, with the final **SI** values for 1995–2000 we began the five-year period

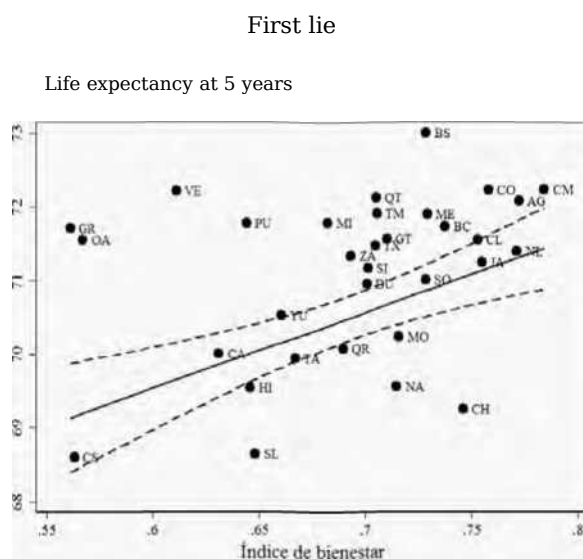
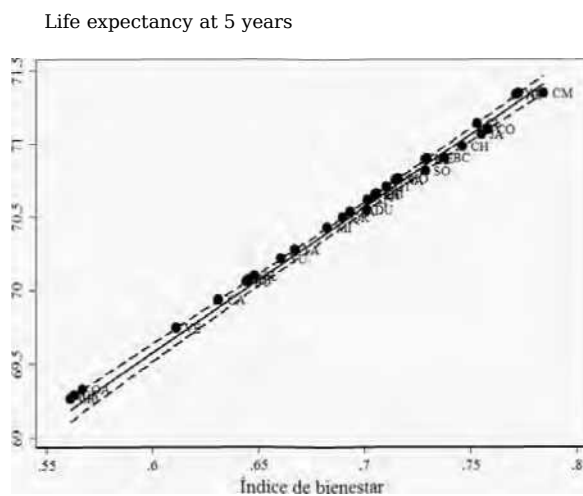
State	Index of welfare	Omission initial	Hope observed	Entrony	Hope initial	Factor 8 to the nation	Hope adapted*	Straight line theoretical	Hope average
Mexican Republic			70.50	0.18					
Aguascalientes	0.7724	0.0286	72.07	0.17	71.71	-0.05	71.14	73.10	72.12
Baja California	0.7376	0.0454	69.20	0.19	68.60	0.19	68.03	72.48	70.25
Baja California	0.7286	0.0069	71.64	0.17	71.55	-0.04	70.98	72.32	71.65
Campeche	0.6313	0.0364	72.67	0.17	72.22	-0.09	71.65	70.57	71.11
Coahuila	0.7579	0.0594	70.73	0.17	70.00	0.08	69.43	72.84	71.14
Colima	0.7528	0.0203	72.03	0.17	71.78	-0.05	71.20	72.75	71.98
Chiapas									
Chihuahua	0.7461	0.0433	69.20	0.18	68.65	0.19	68.07	72.63	70.35
Mexico City	0.7841	0.0143	70.71	0.17	70.53	0.04	69.95	73.32	71.63
Warrior	0.561	0.3274	74.62	0.1854	70.09	0.08	69.51	69.32	69.41
Gentleman	0.645	0.0549	72.08	0.1862	71.34	-0.02	70.77	70.84	70.80
Jalisco	0.754	0.0246	71.27	0.1752	70.96	0.01	70.39	72.79	71.59
Mexico	0.729	0.0000	71.17	0.1827	71.17	-0.01	70.59	72.33	71.46
Michoacán	0.682	0.0582	72.22	0.1767	71.48	-0.03	70.90	71.49	71.20
Morelos	0.715	0.0221	72.42	0.1788	72.13	-0.08	71.56	72.09	71.82
Nayarit	0.714	0.0767	72.86	0.1690	71.92	-0.07	71.34	72.07	71.71
Nuevo León	0.771	0.0377	72.00	0.1631	71.56	-0.04	70.98	73.09	72.03
Oaxaca	0.567	0.0623	70.42	0.1956	69.56	0.12	68.98	69.42	69.20
Puebla	0.644	0.0273	70.61	0.1917	70.24	0.06	69.67	70.81	70.24
Querétaro	0.705	0.0211	71.28	0.1778	71.01	0.01	70.44	71.80	71.17
Durango	0.699	0.0385	73.48	0.1636	71.98	0.1723	69.95	71.00	69.38
Quintana Roo	0.699	0.0385	73.48	0.1636	71.98	0.1723	69.95	71.00	69.38
Cinajuata	0.648	0.0749	72.83	0.1691	71.91	-0.06	71.33	70.88	71.10
San Luis Potosí	0.701	0.0305	72.11	0.1721	71.73	-0.05	71.15	71.83	71.49
Sinaloa	0.728	0.0493	69.86	0.1752	69.25	0.14	68.68	72.32	70.50
Sonora	0.667	0.0100	71.69	0.1832	71.56	-0.04	70.98	71.22	71.10
Tabasco									
Tamaulipas	0.704	0.0122	72.38	0.1777	72.23	-0.09	71.65	71.89	71.77
Tlaxcala	0.611	0.0260	71.74	0.1830	71.39	-0.02	70.82	70.21	70.52
Veracruz	0.660	0.0082	72.17	0.1606	72.08	-0.08	71.50	71.10	71.30
Yucatán	0.693	0.0546	72.91	0.1696	72.24	-0.09	71.66	71.69	71.68
Zacatecas									

* With formula (8.13) from the text.
Source: Population censuses and counts 1970 to 2010 and 2015 survey and vital statistics 1970-2015.

State	Estimator	Standard error	Hope adapted to the country		90% confidence interval		Hope selected
			Estimator	Standard error	Lower limit	Lower limit	
Mexican Republic							
Aguascalientes	71.9712	0.1739	71.32	0.1723	70.82	71.82	71.71
Baja California	71.6115	0.1301	70.96	0.1289	70.58	71.34	70.58
Baja California Sur, Campeche, Coahuila, Colima	7L82ġ1						
	01542	7LT7	01528	7072	7L61	7072	
	71.7689	0.1477	71.12	0.1464	70.69	71.54	71.54
Chiapas							
Chihuahua					m64	7445	7444
Mexico City	72.0928	0.1909	71.44	0.1891	70.89	71.99	70.89
Durango	71.2326	0.1050	70.58	0.1041	70.28	70.88	70.28
Guanajuato	71.3277	0.1083	70.68	0.1073	70.36	70.99	70.99
Warrior	69.7857	0.2551	69.13	0.2527	68.40	69.87	69.87
Gentleman	70.6627	0.1336	70.01	0.1323	69.62	70.40	70.40
Jalisco	71.7893	0.1502	71.14	0.1489	70.70	71.57	70.96
Mexico	71.5253	0.1219	70.87	0.1208	70.52	71.23	71.17
Michoacán	71.0415	0.1059	70.39	0.1049	70.08	70.70	70.70
Morelos	71.3866	0.1115	70.73	0.1105	70.41	71.06	71.06
Nayarit	71.3751	0.1108	70.72	0.1098	70.40	71.04	71.04
Nuevo León	71.9603	0.1724	71.31	0.1708	70.81	71.81	71.56
Oaxaca	69.8476	0.2456	69.19	0.2433	68.48	69.91	69.56
Puebla	70.6455	0.1354	69.99	0.1342	69.60	70.38	70.24
Querétaro	71.2762	0.1063	70.62	0.1053	70.32	70.93	70.93
Quintana Roo	71.1140	0.1044	70.46	0.1034	70.16	70.76	70.76
San Luis Potosí	70.6868	0.1310	70.03	0.1298	69.66	70.41	70.41
Sinaloa	71.2366	0.1051	70.58	0.1042	70.28	70.89	70.89
Sonora	71.5170	0.1212	70.86	0.1201	70.51	71.21	70.51

Tabasco	70.8823	0.1140	70.23	0.1129	69.90	70.56	70.56
Tamaulipas							
Tlaxcala	71.271	0.1271	70.6	0.1257	70.1	71.1	70.8
Veracruz	70.3037	0.1783	69.65	0.1767	69.14	70.17	70.17
Yucatán	70.8136	0.1192	70.16	0.1181	69.82	70.51	70.51
Zacatecas				0.1032	70.20	70.51	70.80

Source: Population censuses and counts 1970 to 2010 and 2015 survey and vital statistics 1970-2015.

Figure 8.2. Life expectancy at age 5 and well-being index by state, 1995-2000**Second attempt**

Note: See Annex C for the meaning of the acronyms

Source: Estimates based on censuses, counts and intercensal survey, 1970-2015 and vital statistics from 1970 to 2015.

We started 2005-2010 with the first ones and, finally, we started 2010-2015 with the last ones. In the seven five-year periods, only the first attempt was required to obtain consistent results.

When comparing life expectancies between men and women, wide or narrow gaps are observed. In order to improve the distinction between the sexes, we extracted from the Coale and Demeny Western model mortality tables the life expectancies for men and women associated with the total life expectancy we had estimated. We averaged the discrepancies between the observed and Western model life expectancies, accepting a maximum difference of five years. Half of this average was subtracted from the total to allocate it to men, and the other half was added to allocate it to women. Finally, for each five-year period and sex, **we normalized** the life expectancies at age 5 to the national total. The final life expectancies are shown

8.3 Annual estimates

Final age-specific mortality rates were obtained by multiplying the initial rates, calculated from registered deaths, by the final correction factors. The age pattern, linking mortality before and from age 5, was smoothed using the Heligman and Pollard model (see Appendix D) ³, and the single-age rates were retained.

From these rates for five-year periods, we estimated those for each year from 1970 to 2015. First, we interpolated them linearly with respect to time for each age and sex separately. For 1970 and 1971, we used the rates from the five-year period 1970-1975, and for 2013 to 2015, those from 2010-2015. Let us denote these rates by $M_{xi}(t)$, which were then multiplied by the average populations obtained in Chapter 6, and from there, the deaths by age and sex for each year, say $D_{xi}(t)$ for year t :

$$D_{xi}(t) = M_{xi}(t) \cdot P_{xti}(t) \quad (8.15)$$

where $P_{xi}(t)$ is the average population. These deaths do not satisfy the national totals estimated in Chapter 5. If we sum over age,

$$Di(t) = \sum_{x=0}^{109} D_{xi}(t)$$

and from these we take the state distribution, by superimposing it on the national total $D(t)$ gives us totals corrected by federal entity ${}_iD(i)$. If we assimilate the national deaths by age $D_x(t)$ as row marginals, the state totals ${}_iD(i)$ as column marginals and those estimated with the rates and populations $D_{xi}(t)$ as initial arrangement, by means of the iterative biproportional assignment algorithm we obtained the definitive deaths by age and sex, say $D_{xi}(t)$.

³ The conversion of rates to probabilities, to fit the Heligman and Pollard model, was done with formulas (D.10) and (D.11) in Annex D. Once the probabilities were adjusted, they were returned to rates with formulas (D.13) and (D.14).

State	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
Men									
Mexican Republic	61.49	62.54	64.07	65.67	66.74	67.91	69.33	68.93	68.35
Aguascalientes	63.17	63.58	65.95	66.74	68.20	68.11	70.31	68.64	68.97
Mexico City	64.35	66.32	66.98	67.21	67.59	67.95	69.78	69.20	69.86
Durango	62.16	62.69	63.62	65.10	66.97	67.50	68.96	68.55	68.04
Guanajuato	61.45	62.16	63.53	65.27	67.00	67.68	69.17	69.42	68.32
Warrior	60.75	60.43	62.35	64.82	66.25	68.48	68.69	68.67	66.31
Gentleman	59.83	60.24	62.17	65.64	66.06	68.91	69.21	69.10	68.45
Jalisco	62.80	64.46	65.43	67.76	66.99	69.11	69.65	69.05	68.29
Mexico	61.96	63.13	64.01	66.48	66.72	68.60	69.50	68.84	69.72
Michoacán	61.08	61.02	62.99	65.27	66.42	67.86	70.43	68.68	68.86
Morelos	61.39	62.09	64.30	65.53	67.46	68.14	70.37	68.93	68.79
Oaxaca	59.33	60.00	62.54	63.83	65.11	65.85	66.64	67.51	68.84
Puebla	59.33	60.00	62.59	62.95	65.17	66.41	67.28	67.81	69.66
Querétaro	60.31	61.94	62.48	64.14	65.35	66.76	67.33	69.17	69.44
Quintana Roo	62.31	63.52	62.83	64.44	65.66	66.88	67.61	67.69	69.58
Coahuila	61.67	62.77	64.91	66.10	67.00	68.31	69.93	69.47	69.25
Colima									
Chiapas			62.58	63.69	64.93	65.85	66.83	67.59	69.39

Nayarit	61.58	62.96	64.47	65.55	67.17	67.94	69.93	68.96	68.97
Nuevo León	63.43	65.23	66.36	66.91	67.56	68.21	70.40	69.20	68.95

San Luis	59.97	61.48	63.46	64.93	66.63	68.04	69.03	68.90	68.45
Potosí	61.35	2.55	63.46	66.30	6.79	67.88	69.75	68.63	67.93
Sinaloa	62.08	63.48	4.78	66.10	66.82	67.42	69.34	68.38	68.05
Sonora	60.85	1.60	63.14	65.71	66.64	67.31	69.20	68.45	67.66
Tabasco									
Tamaulipas	~6L02	~6Z6	~63T	"ft5A4	"ÓGA	W	~6V5	J59	-
Tlaxcala	~	5~	S8~	~	T	67.48	8~	VfT	6843
Veracruz	59.99	60.75	63.11	64.29	65.76	68.06	68.14	68.82	5 -
Zacatecas	61.74	62.93	64.14	66.24	66.93	68.22	69.28	69.13	68.28

Baia California	68.26	70.94	71.96	72.31	72.97	74.25	75.45	74.96	75.39
Baia California Sur	65.06	69.02	70.34	72.06	72.50	73.93	74.89	74.26	75.04
Campeche	64.26	67.15	68.95	70.50	71.24	72.50	73.32	73.46	73.64
Coahuila	68.09	70.21	71.68	72.40	73.08	74.34	75.51	74.69	75.10
Colima	66.66	69.36	71.38	72.56	73.24	73.93	74.95	74.44	73.71
Chiapas	63.50	65.57	67.57	70.07	70.89	72.20	73.26	73.53	72.68
Chihuahua	67.50	70.54	71.89	72.31	72.87	74.33	75.33	75.18	75.00
Mexico City	70.11	72.95	73.27	73.67	72.92	74.70	75.72	75.15	75.50
Durango	65.11	68.48	70.56	71.56	72.08	73.55	74.90	74.63	74.40
Guanajuato	65.82	68.64	70.34	71.72	72.28	73.69	74.65	73.86	74.17
Warrior	64.12	65.50	67.36	69.52	70.66	70.02	72.35	73.12	72.48
Gentleman	65.58	67.33	69.13	68.91	71.85	71.21	74.14	73.93	73.67
Jalisco	67.02	69.75	71.66	71.39	73.31	72.99	75.07	74.78	74.65
Mexico	66.87	69.90	70.97	71.90	73.05	73.15	74.86	74.81	73.42
Michoacán	62.82	65.34	67.07	70.67	71.04	72.39	72.36	74.53	74.82
Quintana Roo	62.82	65.34	66.76	70.07	71.79	72.16	74.47	74.49	74.17
San Luis Potosí	65.09	66.76	69.62	70.24	71.54	72.12	73.69	74.03	73.43
Sinaloa	65.66	68.48	70.30	71.23	72.41	73.31	74.21	74.88	74.63
Sonora	67.77	70.51	71.74	72.56	72.76	74.17	75.11	75.18	74.91
Tabasco	64.20	67.09	68.58	70.60	71.89	73.21	74.10	74.71	74.52
Tamaulipas	66.30	69.38	70.67	71.76	72.50	73.53	74.91	74.91	74.76
Tlaxcala	66.25	68.59	69.85	71.17	72.22	73.36	74.44	73.53	73.98
Veracruz	64.67	67.08	69.42	70.10	71.81	71.97	73.68	73.76	74.00
Yucatán	64.84	67.43	69.60	70.52	71.96	72.33	73.89	73.90	73.91
Zacatecas	64.28	66.84	69.26	70.39	71.83	72.81	74.37	74.14	74.09

Morelos	66.80	69.18	71.26	71.99	72.09	73.34	73.59	74.50	73.64
Nayarit									
Nuevo León	'68N3	2	TME	~7122	Tio	<i>J4A</i>	~7		"749?
Oaxaca	~	ml	T	~	T	<i>T</i>	MXT	73.64	"
Puebla	64.58	65.97	68.02	69.50	71.31	72.68	73.39	74.16	73.02
	66.03	67.83	69.50	70.77	72.20	71.64	74.19	74.35	73.88

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State	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
Total									
Mexican Republic	63.66	65.44	67.08	68.44	69.47	70.50	71.86	71.66	71.24
Aguascalientes	65.07	67.04	68.43	69.53	70.26	71.31	72.57	71.99	71.78
Baja California	65.36	67.31	68.47	69.04	69.78	70.87	72.49	71.90	71.96
Baja California Sur									
Campeche									
Coahuila	65.17	67.24	68.32	69.20	70.09	71.07	72.55	71.89	71.66
Colima	64.12	65.98	68.08	69.29	70.09	71.11	72.44	71.96	71.48
Chiapas	60.59	63.29	65.27	66.80	68.28	69.26	70.30	70.98	70.14
Chihuahua	65.00	67.03	68.34	69.05	69.83	70.96	72.37	71.79	71.57
Mexico City	67.19	69.56	70.06	70.41	70.23	71.32	72.75	72.17	72.68
Durango	63.59	65.51	67.03	68.29	69.50	70.52	71.94	71.59	71.22
Guanajuato	63.59	65.32	66.87	68.46	69.62	70.68	71.92	71.65	71.25
Warrior	62.39	62.88	64.79	67.14	68.43	69.24	70.53	70.89	69.40
Gentleman	62.66	63.71	65.59	67.24	68.93	70.05	71.68	71.52	71.05
Jalisco	64.87	67.02	68.48	69.54	70.13	71.04	72.36	71.92	71.47
Mexico	64.37	66.44	67.42	69.15	69.86	70.87	72.19	71.83	71.56
Michoacán	63.15	64.49	66.40	68.08	69.38	70.40	71.65	71.51	70.94
Morelos	64.05	65.55	67.71	68.73	69.75	70.73	71.99	71.72	71.22
Nayant	63.38	65.45	67.35	68.61	69.74	70.72	72.01	71.73	71.30
Nuevo León	65.89	67.97	69.08	70.03	70.26	71.30	72.70	72.15	71.95
Oaxaca	61.67	62.34	64.47	66.23	68.12	69.30	70.72	71.01	70.42
Puebla	63.11	64.20	65.96	67.51	69.02	70.03	71.37	71.42	70.89
Querétaro	63.15	65.08	66.80	68.33	69.51	70.63	71.97	71.76	71.59
Quintana Roo	62.52	64.35	66.48	68.24	69.36	70.47	72.04	71.81	71.37
San Luis Potosí	62.49	64.04	66.47	67.55	69.06	70.07	71.36	71.47	70.94
Sinaloa	63.46	65.44	66.82	68.73	69.57	70.59	71.99	71.76	71.28
Sonora	64.88	66.91	68.20	69.29	69.77	70.79	72.23	71.78	71.48
Tabasco	62.48	64.26	65.79	68.12	69.24	70.25	71.66	71.58	71.09
Tamaulipas	64.31	66.21	67.56	68.51	69.58	70.63	72.09	71.80	71.32
Tlaxcala	63.59	65.54	66.80	68.37	69.55	70.62	72.02	71.74	71.31
Veracruz	62.29	63.83	66.20	67.16	68.76	69.72	70.92	71.30	70.64
Yucatán	62.99	64.77	66.62	68.14	69.19	70.19	71.38	71.44	70.90
Zacatecas	62.97	64.80	66.63	68.28	69.36	70.51	71.83	71.64	71.18

Source: Population censuses and counts 1970 to 2010 and 2015 survey and vital statistics 1970-2015.

Finally, the interpolated rates were modified by the factor $D'(t)/D(t)$, such that when multiplied by the mean populations, the sum over age satisfied the total $D_i(t)$. *The modified rates were smoothed again using the Heligman and Pollard model* . These smoothed rates and the associated probabilities of death were taken as definitive.

9 Internal and international migration of states

The transformation of the economic model, experienced by Mexico in the past thirty-five years, from one oriented towards the production of goods and services to satisfy domestic consumption, known as import substitution industrialization, to another aimed at international markets within the process of globalization of the world economy, has impacted various areas of national life.

Among the implications of this shift in economic focus is internal migration within the country. While still significant, the flow from rural to urban areas has given way to intercity migration; even migration from larger cities to smaller ones has emerged as the dominant pattern, a clear reflection of faster growth in intermediate cities (100,000 to less than 1 million inhabitants) than in large metropolises (1 million or more). But not only has intercity mobility gained importance, but also migration between rural areas and, not insignificantly, from urban to rural areas (Partida, 2014).

These changes in the orientation and volume of migratory flows are also perceived in the exchanges of inhabitants between the federal entities; however, the overall intensity of interstate flows has decreased over the years, even reducing its amount in the first five years of the current century, although—in absolute terms—the 2010 census reports a rebound and the 2015 intercensal survey a slight decrease; but, in relative terms, the long-term downward trend remains.

The marked shift in migration to the outside in recent years, for its part, entails changes in its state distribution, inherent to the characteristics of the phenomenon, both in the federal entities with a migratory tradition, as well as in the emerging ones.

This chapter is dedicated to estimating both interstate and international migration to and from the 32 federal entities.

We begin with external migration, because the exercise is simpler, as it is reduced to territorially distributing the national flows estimated in chapter 4 (emigrants).

Internal migration, on the other hand, requires a more complex treatment, since a necessary and sufficient condition is that the sum of immigrants to the 32 federal entities is equal to the sum of their emigrants.

9.1 International migration

9.1.1 Migrants

Let's begin with emigration. In Chapter 4, we obtained the amounts by age and sex for each year of total emigration to other nations. The addition of departures to countries other than the United States was done using data collected from the expanded questionnaire (sample) of the 2000 and 2010 Mexican censuses, as well as from the international migration modules of the National Survey of Demographic Dynamics (ENADID) of 1992 and 1997, which ask whether any member of the household has gone to live in another country in the previous five years.

From the same data sources, we can obtain the territorial distribution of the origin of these migrations. The proposal is to overlay these figures onto the national totals from Chapter 4, thus providing data on migration abroad from each federal entity.

In proceeding in this way, we take into account two assumptions implicit in the procedure, which are the same as the facts when adding emigrants to nations other than the United States in Chapter 4:

1. The proportion of households that move completely, out of the total that had at least one migrant in the previous five years, is not significantly different among the federal entities.
2. The proportion of households with migrants that dissolved before the interview is also not significantly different between states.

We must acknowledge the first scenario, since the entire household has migrated, and therefore there is no one to report the displacement in the census. Similarly, we require the second scenario, because when the survivors of the dissolved household join another, the migrant from the former household is no longer part of the new one and, consequently, is not counted in the census or the ENADID survey.

If both assumptions were not met with any degree of accuracy, it is clear that the state-level distribution used would be biased toward the "real" distribution. While alternative sources exist, their smaller sample sizes, often insufficient at the state level, or lacking the necessary breakdown to geographically distribute migrants, would further call into question the viability of these assumptions. The large sample size in each state in the censuses supports the assumptions, at least from a statistical point of view. The ENADID sample, although significantly smaller, provides accurate estimates.

Our time frame for reconciliation covers the period 1970-2015, and from the ENADID surveys and censuses we only have information for the five-year periods 1987-1992, 1992-1997, 1995-2000 and 2005-2010. The distribution from the 1987-1992 ENADID survey was adopted for the five-year periods of 1970-1990, the distribution from the 1992-1997 ENADID survey for the five-year period, the average of the census data from 2000 and 2010 for 2000-2005, and the average of the 2005-2010 period was assumed to be the same for the following five-year period.

That choice rests on the following reasoning. The temporal trend of the country's total emigrants reveals that, until 2005, the growing mass emigration to the United

This dates back to the 1940s, after the economic recession in the United States ended and the Bracero Program agreement was signed in 1942. This process shaped a particular state-level distribution of the flow of migrants. On the one hand, several states maintained their dominance over the years, commonly referred to as "traditional" states, while only recently have others emerged with a significant contribution. The distribution from the 1992 National Survey on Demographic Dynamics (ENADID) should be considered representative of the period 1970-1990.

The ENADID international migration modules and censuses also ask about the age, sex, and current place of residence of migrants. We omitted age and sex because, by splitting the sample of a statistically small phenomenon, statistically insignificant age compositions can be obtained. Furthermore, there is sufficient evidence that international migrants are concentrated between 15 and 40 years of age, a pattern observed in departures from our country from 1970 to 2015. We therefore decided to overlay the national age and sex structure for each year onto the totals for each federal entity. Estimates were made by five-year age groups and for each of the five-year periods of the 1970-2015 period.

9.1.2 Immigrants

We followed a similar procedure to that used for emigrants, that is, to detach the territorial distribution of arrivals to the country from the censuses of 1980 to 2010 and the intercensal survey of 2015, and superimpose it on the national totals derived from the reconciliation of the chapter

5. However, due to the change in question in the 1990 and 2000 censuses, we do not have the distribution for 1980-1985 and 1990-1995; their values were estimated as the average of the distributions of the five-year periods surrounding them.¹ The adaptation to the national figures, estimated in chapter 4, was done for each sex and five-year age group separately.

The rates by five-year age groups, obtained with equations (4.5) to (4.7), were retained and multiplied by the person-years lived, calculated as described at the beginning of section 8.2. Let us denote these immigrants by $s I_{x,j}$ **and their sum by age. The spatial distribution of these totals was multiplied by the national total for the five-year period**, thus obtaining the number of immigrants from each entity during the period $sav_{x,j}$:

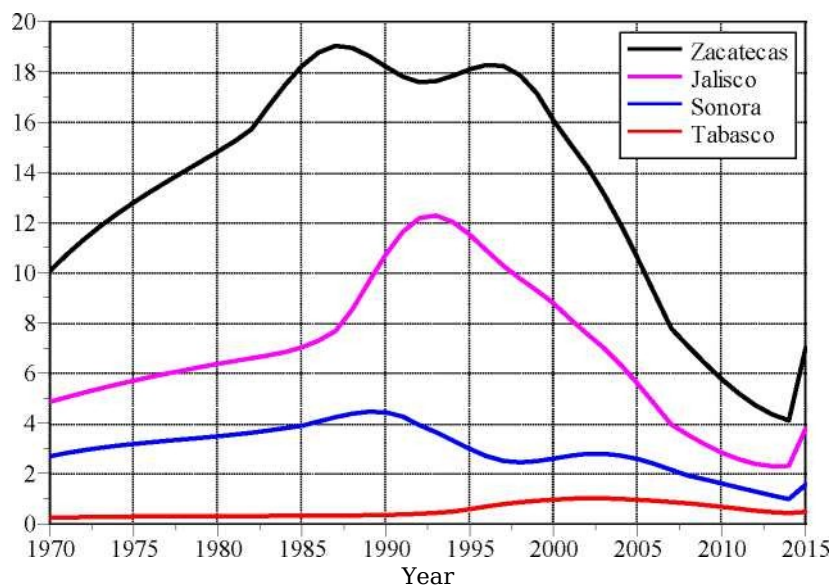
9.2 Interstate migration

In the censuses from 1990 to 2010, the 2005 count, and the 2015 survey, respondents were asked about their state of residence five years prior. Let's say these $n_{x,j}$ are the people in the semi-open interval of exact ages $[x, x + 5)$ residents in state j at the time of the census and in state i five years prior. This information is not collected for individuals

¹ Even in the five-year period 2000-2005 when it reached its historical peak, it represented 0.6% annually of the population of Mexico.

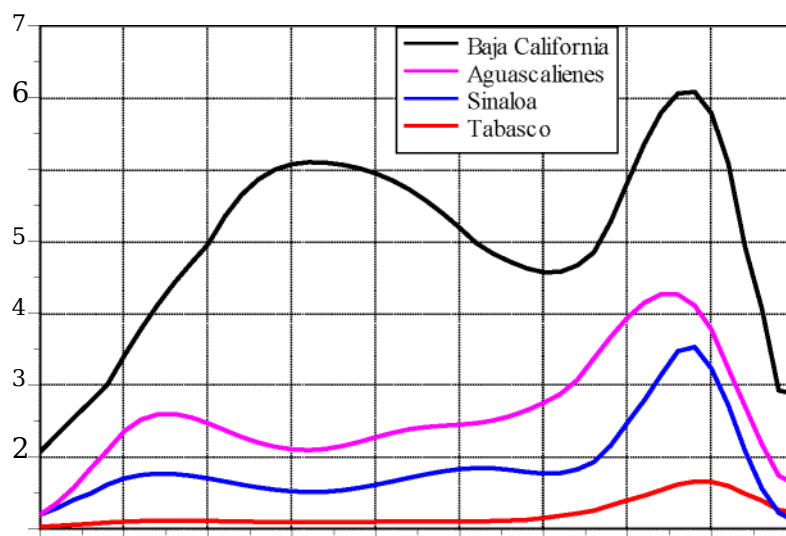
² Partida's (1993) correction was used on the 1980 census data.

Figure 9.1. Annual rates of international emigration
for four selected states, 1970-2015
(Per thousand)



Source: United States Censuses from 1970 to 2000 and American Community Survey from 2000 to 2015; ENADID 1992 to 2014 and 2015.

Figure 9.2. Annual rates of international
immigration
for four selected states, 1970-2015



1

Source: Population censuses from 1960 to 2010, population count of 2005 and Intercensal Survey of 2015.

Five years, because five years prior they were not yet born. However, since five years prior is the earliest point in the five-year period, for children under five years of age, that point is their birth. Thus, we can consider the region of birth for children from zero to four years old as their place of origin in the five-year period prior to the population count. For the 1980 census, respondents were asked about the length of residence in the state where they were counted and their state or country of origin, thus directly documenting the migration of children under five years of age. If we sum by origin, we get the total number of immigrants to state j :

$$\sum_{i=1}^{32} I_{ij} = \sum_{i=1}^{32} I_{ij} \quad (9.1)$$

And if we do it for the destination, we have the total number of emigrants from i :

$$\sum_{j=1}^{32} O_{ij} = \sum_{j=1}^{32} O_{ij} \quad (9.2)$$

such that, by (9.1)

$$\sum_{j=1}^{32} S_{x,i,j} = \sum_{j=1}^{32} S_{x,i,j} \quad (9.3)$$

Because the proportions $S_{x,i,j}$ are positive, less than one, and satisfy (9.4), they are often called **probabilities**. We say “transit” and not “emigrate,” because we only know that at the beginning of the period they were in i and at the end in j , but we do not know whether they actually arrived directly in j from i , or whether in the interim they lived in another state.

In demography, a rate expresses an annual per capita average of events; however, only those rates that refer to the entire population exposed to the risk of experiencing the event can be converted into probabilities, and vice versa. These types of rates are called first-category rates (Leguina, 1976: 39-41). It is clear that while everyone in a region is exposed to emigration, no one is exposed to immigration, since if someone is already in the region, they cannot enter. Thus, it is the emigration rates that can be converted into proportions.

S_{mx} denote the rate of emigration from region i to region j during a specific five-year period. If we define the transition proportions matrix as:

$$\begin{array}{c}
 \begin{array}{c} \wedge \\ 55- \\ 1,1,2 \end{array} \quad \begin{array}{c} bS_{x,2,l} \\ \$S_{x,2,2} \end{array} \quad \begin{array}{c} hS_{x,32,l} \\ \$S_{x,32,2} \end{array} \\
 \text{and} \\
 \begin{array}{c} 55c,1,32 \end{array} \quad \begin{array}{c} \$S_{x,2,32} \\ / \end{array} \quad \begin{array}{c} \$S_{x,32,32} \end{array} \\
 5 M_x, 1 \\
 j \quad bM_{x,2,l} \quad 5 M_{r,32,l} \\
 2 \therefore 1,2 \quad \begin{array}{c} 32 \\ E \\ m \end{array} I \quad 5 M_{x,32,2} \\
 r,l,32 \quad bM_{x,2,32} \quad \bullet \bullet \bullet - \quad 5 M_{x,32,j} \quad |
 \end{array} \quad (9.5)$$

$$\begin{array}{c}
 \begin{array}{c} 32 \\ E \\ m \end{array} I \quad 5 M_{x,32,2} \\
 \bullet \bullet \bullet - \quad 5 M_{x,32,j} \quad |
 \end{array} \quad (9.6)$$

1/32

Nour and Suchindran (1984: 326) found the following relationship

$${}_s S_x = \exp\{{}_5 M_x\} \quad (9.7)$$

either

$$\cancel{{}_5 M_x = \ln\{{}_b S_x\}} \quad (9.8)$$

where (Gantmacher, 1959: 113):

$$\begin{array}{c}
 - \ln f^{A^*} I + A + S^{A^*} + S^{A^*} + \dots \\
 \text{of } i \text{ y-i} \\
 \{MA\}^* = EM - (AI)^* = (AI)^i_Z - (AI)^i_O + \wedge (AI)^i
 \end{array} \quad (9.9)$$

with I being the identity matrix. Both are inverse functions, that is,

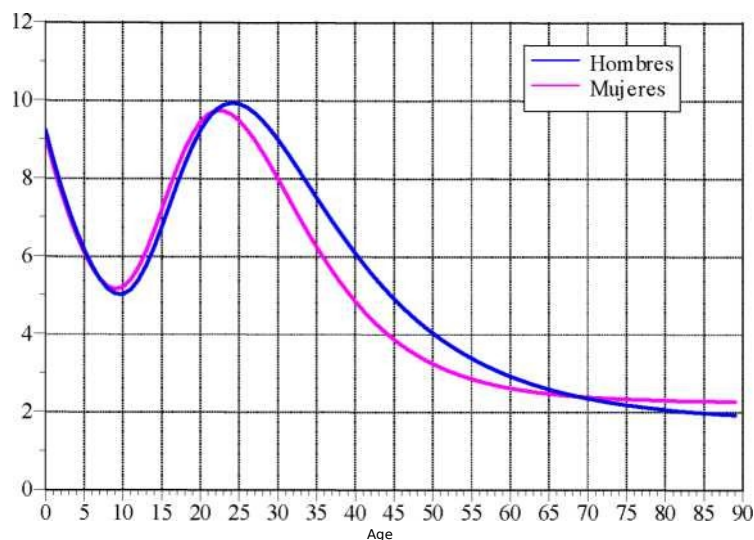
$$\begin{array}{c}
 e^{**} \quad \{A\} = \ln\{e^A\} = 1 \\
 (9.10)
 \end{array}$$

In all cases, formula (9.8) was used to estimate migration rates, except for children under five years of age, since these children are exposed to the risk of migrating, on average, for only half of the five-year period; thus, the rates, as an annual average, are:

$$\begin{array}{c}
 5. \\
 - \ln\{{}_5 S_o\} \\
 M_o = \\
 (9.8')
 \end{array}$$

The rates calculated with (9.8) and (9.8') are per cohort, since the probabilistic sense of the proportions $b s x j_L$ implies that the exposure to risk, the denominator in (9.3), was **for**

Figure 9.3. Interstate migration rates for the entire country by age and sex, 2010-2015 (Per thousand)



Source: Prepared based on the 2015 Inter-Monthly Survey.

We convert cohort rates into age group rates because the latter are easier to interpret graphically and also allow us to multiply them by the average population to estimate migrants; graphically, we need to move from the Lexis diagram on the left in Figure 4.2 to the diagram on the right. Following the same reasoning that led us to establish equation (4.16), we can:

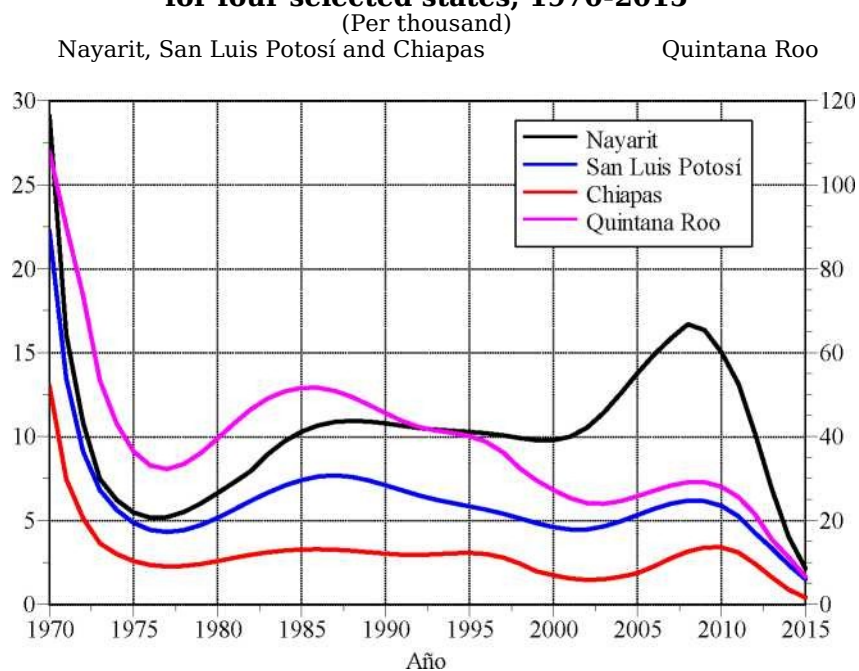
$$(9.11)$$

where now ${}_5M_{x,t,t}$ indicates the age-period rate (the right side of figure 4.2).

The rates for 1970-1980 were derived from Partida's (1993) estimates, for 1985-1990 and 1995-2000 from the 1990 and 2000 censuses, and for the three five-year periods from 2000 to 2015 from the 2005 count, the 2010 census and the 2015 intercensal survey. The rates for 1980-1985 and 1990-1995 were taken as the arithmetic mean of the five-year periods that border them.

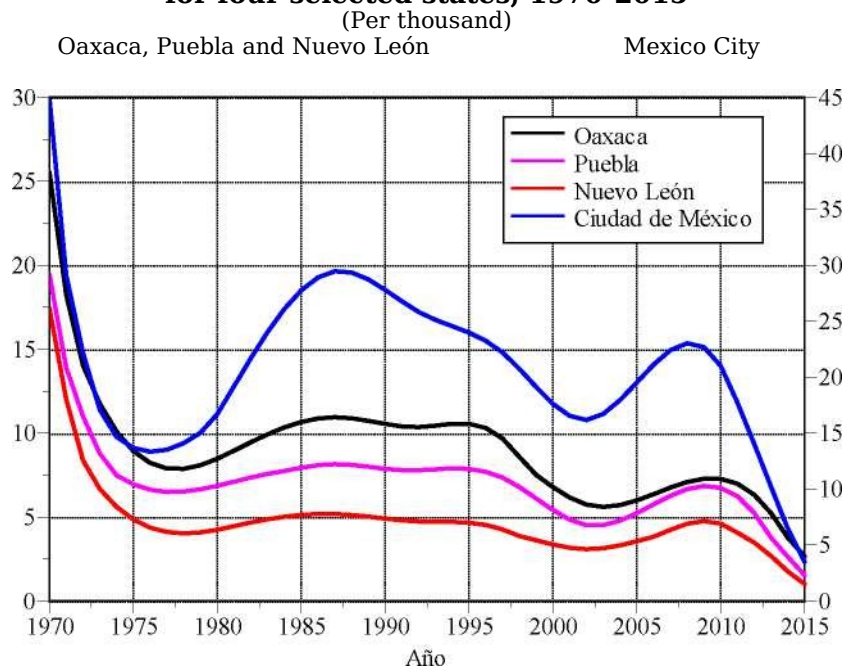
Figure 9.3 presents the age-period rates for the country as a whole for the most recent five-year period. The classic pattern of internal migration is evident. The high intensity in early childhood is linked to the high incidence among young people and young adults, presumably indicative of children migrating with their parents, within a framework of territorial mobility of entire families during the household formation stage. The female rejuvenation of the "work bell curve" points to the increasing youth of women entering into unions by choice, again within a pattern of family migration. Figures 9.4 and 9.5 present the gross internal migration rates for the states, covering the range of state-specific characteristics.

**Figure 9.4. Annual rates of internal migration
for four selected states, 1970-2015**



Source: Population censuses 1980 to 2010, population count of 2005 and intercensal survey of 2015.

**Figure 9.5. Annual rates of internal emigration
for four selected states, 1970-2015**



Source: Population censuses 1980 to 2010, population count of 2005 and intercensal survey of 2015.

Annexes

A. The iterative biproportional allocation

Among the various procedures available for estimating the cells of a two-variable tableau, the iterative biproportional allocation method has the property of being maximum likelihood (Willekens, Pór, and Raquillet, 1981).¹ The algorithm consists of proportionally distributing the difference between the known marginals and those of the resulting array after each iteration.

Let E_{ij} be a bivariate array, where i indicates the row and j the column, of which an initial representative array —say E^0 — and the row and column marginals are known:

$$E_{i, \cdot} = E^0_{i, \cdot} \text{ and } E_{\cdot, j} = E^0_{\cdot, j}$$

where m is the number of rows and n the number of columns.

If the procedure is started row by row, for each of the i rows the difference is distributed proportionally among the n columns:

$$E_{ij}^{(1)} = E_{ij}^0 + \frac{E_{i, \cdot} - E^0_{i, \cdot}}{E^0_{i, \cdot}} E^0_{ij}$$

and the difference with respect to the resulting arrangement is now distributed among the m rows of each column j :

$$E_{ij}^{(2)} = E_{ij}^{(1)} + \frac{E_{\cdot, j} - E^0_{\cdot, j}}{E^0_{\cdot, j}} E_{ij}^{(1)}$$

thus completing the first iteration (indicated by the superscript 1).

The procedure is applied successively until the array converges, that is, until after k iterations the following condition is satisfied:

$$|E_{ij}^{(k)} - E_{ij}^{(k-1)}| < \epsilon$$

for all $m \times n$ cells of the array and where ϵ is arbitrarily fixed (0.5 in all applications mentioned previously in this document).

¹ Deming (1943) developed the solution under the least squares criterion.

B. Methods to correct the level of mortality

The objective of this appendix is to briefly present two algorithms for evaluating the relative coverage of deaths in vital statistics compared to population censuses, whose application to the case of Mexico and its federal entities is described in Chapters 2 and 6, respectively. The procedures are based on the model I call **the general growth model**, which is known among demographers as the **r-variable model**.

It is assumed that the eventual reader has a basic knowledge of the relationships underlying the construction of a life table and the concept of rate in Demography.

BI The general growth model

It is worth remembering the two basic concepts relating to age that are commonly used in Demography:

Exact age. It is the time measured in years that has passed between the **precise** moment the person is born and the **precise** moment the observation is made.

Completed age. This refers to the last birthday reached by a person at the time of observation; it is equivalent to removing **all** the fractional part of the exact age.

$P(t)$ denote the total population at time t , and let $nP_x(t)$ denote the people in that population who are in the open interval of exact ages $[x, x + n)$ at time t , with n measured in years. For example, $5/25P(t)$ indicates the people between the exact ages of 25 and 30 years, or 25-29 years old. The left subscript is generally omitted when it is equal to one ($n = 1$).

Our perception of reality tells us that there is an extremely advanced age—beyond 110 years, which we will denote by **cu**—that no one survives. If we assume that the data are given by **simple** or **expanded ages** (i.e., $n = 1$), it is clear that the

The Gerontological Research Group and the Guinness World Records recognize Jeanne Calment (February 21, 1875 - August 4, 1997), a French woman who lived 122 years and 124 days, as the oldest verified human being. Christian Mortensen (August 16, 1882 - April 25, 1998), born in Denmark and later a naturalized American citizen, is the oldest living man, having lived 115 years and 252 days. Information taken from the website http://en.wikipedia.org/wiki/Main_Page.

The total population is equivalent to the sum of people of all ages;

$$P(t) = \sum_{x=0}^{u-1} P^*(t) \quad (\text{B1})$$

where, for practical purposes, we assume that u is an integer. If the population were grouped into age intervals of equal length n , and we make u a multiple of n , we can write (B1) as:

$$P(t) = \sum_{x=0}^{u/n-1} P^*(t) \quad (\text{B2})$$

The letter n , below the summation subscript, indicates that it should be increased by n and **not** by one as is traditionally evaluated; the most common value of n , besides 1, is 5.

We have defined the concept of exact age and referred the population to a specific moment in calendar time. What can we say about individuals of age x at time t ? Very little, because it would only be a dichotomous variable (0 or 1). Let's consider, for example, the range between 0 and 100 years of exact age. If we could accurately capture exact age in seconds in a population census, we would need 3,153.6 million people (100 years $\times$ 365 days $\times$ 24 hours $\times$ 60 minutes $\times$ 60 seconds)—more than the combined population of China and India (2,589.1 million in mid-2011) and almost half the world's population (6,974.0 million)!—to be able to place just **one individual at each exact age**. Thus, it is necessary to define the limits of this concept, which will be very useful in the exposition. ²

If we divide the population ${}_n P_x(t)$ by the length of the age interval, that is, ${}_n P_x(t)/n$, we obtain an annual average population at time t . If we reduce this as much as possible

that interval that is

$$N(x]t) = \lim_{n \rightarrow 0} \frac{{}_n P_x(t)}{n} \quad (\text{B.3})$$

We have the **annual population density of exact age x with respect to age** at time t .

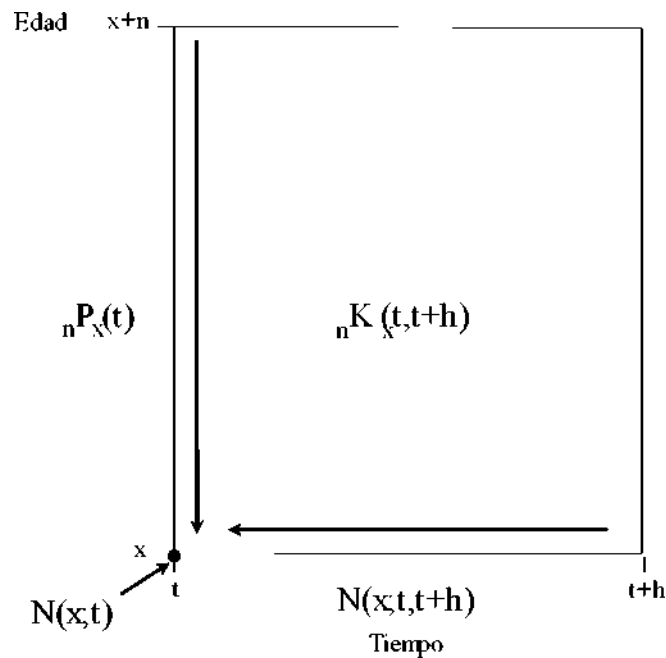
Let $N(x]t, t+h)$ denote the population that reaches the exact age x (the x -th anniversary) between times t and $t+h$, with h measured in years. For example, $N(5; 1998, 2003)$ represents those who turned five years old between January 1, 1998 and January 1, 2003.

If we reduce the period of h years as much as possible:

$$N(x]t) = \lim_{h \rightarrow 0} \frac{N(x]t, t+h)}{h} \quad (\text{B.4})$$

We have the **annual population density of exact age x with respect to time** t .

Lexis diagram exemplifying the equivalence of annual population densities with respect to age and with respect



Why do we use the same notation for annual population densities with respect to age and with respect to time? Simply because it is the same population amount. Indeed, if we plot the populations ${}_n P_x(t)$ and $N(x;t,t+h)$ on a Lexis diagram, as shown in graph B1, from an age perspective, as n decreases, the older generations are eliminated until only the most recent one remains, that is, the one born at time $t - x$; and from a time perspective, removing the more recent generations leaves only the oldest one, that is, the same cohort born at $t - x$. Thus, since age is also a measure of time, in the limit the annual population density in (B.3) and in (B.4) become indistinguishable, since both represent the same survivors of the generation born at $t - x$.

$$N(x;t) = \lim_{n \rightarrow 0} \frac{{}_n P_x(t)}{nh} = \lim_{h \rightarrow 0} \frac{N(x;t,t+h)}{h} \quad (B.5)$$

Let us now consider small intervals of time dt and age dy , which are equal ($dt = dy$) because as calendar time progresses, a person ages in the same amount of time. During that period, by the principle of the compensating equation extended to cohorts, the change in population will be equal to minus the deaths plus the net migrants.

$y(x;t)$ denote the instantaneous mortality rate of exact age x at time t and $X(x;t)$ the net migration rate. It is worth remembering that a rate, regardless of the lengths of the age and time intervals, is always an annual per capita average. Thus, the deaths and net migrants for that small interval

The time **dy values** are $N(y, t) / (y; /) dy$ and $iV(y; t) A(y; t) dy$, respectively. The change in cohort size represented by the annual population density $N(y; t)$ is the total differential (simultaneous variation of age y and time t):

$$dN(y; t) = -N(y; t) y(y; t) dy + N(y, t) A(y; t) dy \quad (B.6)$$

From multivariable differential and integral calculus we know that the total differential of a function is the sum of the partial derivative with respect to each of the variables multiplied by the differential of the variable, that is,

$$dN(y; t) = -iV(y; t) dy + -iV(y; t) dt \quad (B.7)$$

Since the left-hand side of (B.6) and (B.7) expresses the same value, we can equate the right-hand sides:

$$\begin{aligned} d \text{—————} 0 \\ -iV(y; t) dy + -N(y; t) dt = -N(y, t) y(y; t) dy + N(y; t) A(y; t) dy \end{aligned} \quad (B.8)$$

If we divide both sides by the annual population density J -

$$\begin{aligned} \frac{N(y; t)}{N(y; t)} \frac{dN(y; t)}{N(y; t)} = -Kv, t) dy + A(y; t) dy \quad (B.9) \\ \frac{1}{N(y; t)} \frac{dN(y; t)}{N(y; t)} = r(y; t) \end{aligned}$$

Therefore, when replacing in (B.9):

$$\frac{N(y, t)}{dy} + r(y; t) dt = y(y; t) dy + A(y; t) dy$$

and clear

$$\frac{d}{dy} \ln \{iV(y; t)\} dy = r(y; t) dy - y(y; t) dy + A(y; t) dy \quad (B.10)$$

where we replace dt with dy in the growth rate multiplication because both differentials are equal.

If we integrate on both sides of (B.10) between the exact ages a and x :

$$\int_a^x \frac{1}{J} \sim \ln_d y = \ln \frac{N(x; t)}{N(a; t)} = \int_a^x r(y; t) dy - \int_a^x y(y; t) dy + \int_a^x A(y; t) dy \quad (B.11)$$

We take the exponential on both sides:

$$\frac{N(x; t)}{N(a; t)} = \exp \left[- \int_a^x r(y, t) dy + \int_a^x \frac{A(y, t)}{L(y, t)} dy - \int_a^x j(y, t) dy \right]$$

and we clear:

$$N(x-, i) = N(a, t) \exp \left[\int_a^x r(y, t) dy + \int_a^x \frac{A(y, t)}{L(y, t)} dy - \int_a^x j(y, t) dy \right] \quad (B.12)$$

This is the fundamental equation of the general growth model, obtained by Preston and Coale (1982: 257). In a stable population, the growth rate is invariable with age and time, that is, $r = r(y, t)$; this is why the model expressed in (B.12) has been called the variable *r's model*.

If we divide by the population aged a years or older:

$$c_{a+}(x-, t|i) = \frac{N(x; t)}{N(a; t)} \exp \left[\int_a^x r(y, t) dy + \int_a^x \frac{A(y, t)}{L(y, t)} dy - \int_a^x j(y, t) dy \right] \quad 0 \leq a < o \quad (B.13)$$

where $c_{a+}(x; i)$ is the proportion of the population aged a years or older that is exactly age x at time i ; that is, the *age structure or composition* of people aged a years or older; and $b_{a+}(t) = N(a, t)/P_{a+}(t)$ is the *crude birth rate* at time t for the population aged a years or older. We call it the *birth rate* because the annual population density of exactly age a represents the number of new entrants into the open interval a years or older, which is equivalent to the "births" of the population in that age interval. From the definition of age structure, we have:

$$\int_a^o c_{a+}(x-, t) dx = 1 \quad (B.14)$$

Therefore, when integrating both sides of (B.13) over the entire age range

$$1 = \int_a^o c_{a+}(x-, t|i) dx = \int_a^o \frac{N(x; t)}{N(a; t)} \exp \left[\int_a^x r(y, t) dy + \int_a^x \frac{A(y, t)}{L(y, t)} dy - \int_a^x j(y, t) dy \right] dx$$

clear

$$b_{a+}(t) = \frac{1}{N(a; t)} \int_a^o \left[\int_a^x r(y, t) dy + \int_a^x \frac{A(y, t)}{L(y, t)} dy - \int_a^x j(y, t) dy \right] N(x; t) dx$$

and replace in (B.13):

$$c_{a+}(x; t) = \exp \left[- \int_0^x r(y, t) dy + \int_0^x A(y; t) dy - \int_0^x y(y; t) dy \right] \quad 0 \leq a < u \quad (B.15)$$

That is, the age composition can only be deduced from the growth rates, net migration, and mortality at the same time.

Let $B(t, t + h)$ denote the births occurring between times t and $t + h$, and let the annual birth density be:

$$B(t) = \lim_{h \rightarrow 0} \frac{B(t, t + h)}{h} \quad (B.16)$$

Since the exact age zero is the moment of birth, $B(t) = N(0; t)$ and we can write (B.12) as:

$$N(x; t) = B(t) \exp \left[- \int_0^x r(y, t) dy + \int_0^x A(y, t) dy - \int_0^x y(y; t) dy \right] \quad (B.13')$$

$$\begin{aligned} & - \int_0^x r(y; t) dy + \int_0^x A(y; t) dy - \int_0^x y(y; t) dy \\ & \exp \left[- \int_0^x r(y; t) dy + \int_0^x A(y; t) dy - \int_0^x y(y; t) dy \right] \\ & \exp \left[- \int_0^x r(y; t) dy + \int_0^x A(y; t) dy - \int_0^x y(y; t) dy \right] \end{aligned} \quad (B.13')$$

where $b(t)$ is the crude birth rate and it is assumed that:

$$\frac{CJ}{Jc^{\wedge}t)d} = 1 \quad (B.14-)$$

Half a century ago, Alvaro López (1961) proved the **weak ergodicity theorem**, which states that, in the long term, the age structure and growth rate of a population

It is primarily determined by this dynamic and to a lesser extent by the remote population size, that is, the population from which demographic change is considered. Why then does the age structure depend only on the rates for a given moment (i)? Because the growth rates $r(y; t)$ They contain the demographic past of the population (Preston and Coale 1982: 228-230).

In practice, the data are reported by completed age, not by exact age. Likewise, growth rates and net migration by age cannot be assessed at a precise moment, but rather for short or long periods, depending on data availability. Before exploring how to approximate the equations to age groups and time intervals, we believe it is best to explore the model's potential for evaluating and correcting demographic measures, maintaining a continuous approach, since any approximation from this perspective to the discrete case is maintained in all equations.

B.2 Mortality correction based on the general model

We will most likely obtain the age growth rates from two successive population censuses, and the mortality and net migration rates from annualizing the amount of those events and dividing by the population at the midpoint of the time period.

There is evidence that our country's demographic data suffer, to a greater or lesser extent, from underreporting and misreporting of age. Let's assume we have already corrected the problems of misreporting age, but coverage problems persist. Let's say that growth rates, net migration rates, and mortality rates each need to be corrected by the same proportion at all ages, as follows:

$$\underline{r(y, t) = k_r \cdot r(y; t) \quad l(y, t) = k_x \cdot X(y, t) \quad ji(y, t) = k^y \cdot j(y, t)} \quad (\text{B.17})$$

where the symbol $\hat{}$ indicates estimated or **correct** and A: the proportion by which one must correct the rates for all ages.

Taking the natural logarithm on both sides of (B.14) and introducing the correction factors:

$$\ln\{c_{a+}(a; i)\} = \ln\{6_{a+}(i)\} - k_r \int_a^x r(y; t) dy + k_x \int_a^x X(y, t) dy - k_m \int_a^x n(y; t) dy$$

If we consider various values of the exact age, we can estimate the correction factors and the crude birth rate $b_{ah}(/,)$ (ordinate to the origin) by means of an ordinary least squares regression.

This model allows us to obtain not only corrections to the level of mortality (k_m), but also to net migration (k_x), intercopping growth (Δy), and an estimate of $b_{a+}(t)$ which can be useful to us to estimate fertility levels if we set $a = 0$.

B.3 The proposal of Bennet and Horiuchi

A well-known equality of the life table is:

$$p(x; t) = \exp \left(- \int_0^x i(y; t) dy \right) \quad (B.19)$$

where $p(x; t)$ is the probability of surviving from birth to the exact age x in the mortality table for the conditions of time t . Replacing (B.19) in (B.12') we have:

$$N(x; t) = B(t) \exp \left(- \int_0^x i(y; t) dy \right) \quad (B.20)$$

or

The annual density of deaths of exact age x is:

$$D(x; t) = N(x; t) i(x; t) = B(t) \exp \left(- \int_0^x i(y; t) dy \right) i(x; t)$$

and since $d(x; t) = D(x; t) / N(x; t)$ is the annual death density of the life table for a unit radix, we have that:

$$d(x; t) = i(x; t) \quad (B.21)$$

If we integrate both sides of (B.10) de x a $x + v$, we take the exponential and solve for:

$$N(x + v; t) = N(x; t) \exp \left(- \int_x^{x+v} i(y; t) dy \right) \quad (B.22)$$

because the conditional probability of survival of tjC to $tjC + v$ is:

$${}_vP_x = \frac{p(x + v; t)}{p(x; t)} = \exp \left(- \int_x^{x+v} i(y; t) dy \right) \quad (B.19')$$

The annual death rate is now:

$$d(x; t) = \frac{D(x; t)}{N(x; t)} = i(x; t) \quad (B.23)$$

if we clear

$$N(x; t) = \int_0^{x+v} D(x+v; t) \exp \left(- \int_0^{x+v} r(y; t) dy \right) - \int_0^{x+v} X(y; t) dy$$

t)

$$N(x; t) / \left(\int_0^{x+v} D(x+v; t) \exp \left(- \int_0^{x+v} r(y; t) dy \right) - \int_0^{x+v} X(y; t) dy \right) = 1 \quad (B.24)$$

because

$$\frac{D(x+v; t)}{p(x; t)} = \frac{p(x; t)}{p(x; t)} = 1$$

To simplify the notation let's make $\gamma(y; t) = r(y; t) - X(y; t)$, say the *natural* (total less social) *growth rate of exact age a t* time t.

Separating the integral on the right-hand side of (B.24) gives:

$$N(x; t) = \int_0^{x+n} D(x+v; t) \exp \left(- \int_0^{x+v} \gamma(y; t) dy \right) dv + \int_{x+n}^{x+v} D(x+v; t) \exp \left(- \int_0^{x+v} \gamma(y; t) dy \right) dv$$

The exponential of the last term can also be opened into two intervals:

$$\exp \left(- \int_0^{x+v} \gamma(y; t) dy \right) = \exp \left(- \int_0^{x+n} \gamma(y; t) dy \right) \exp \left(- \int_{x+n}^{x+v} \gamma(y; t) dy \right)$$

Since in that term $x+n < v < !$, the first multiplicand of the previous equation does not depend on v, we can take it out of the integral:

$$N(x; t) = \int_0^{x+n} D(x+v; t) \exp \left(- \int_0^{x+v} \gamma(y; t) dy \right) dv + \int_{x+n}^{x+v} D(x+v; t) \exp \left(- \int_0^{x+v} \gamma(y; t) dy \right) dv$$

$$+ \exp \left(- \int_0^{x+n} \gamma(y; t) dy \right) \int_{x+n}^{x+v} D(x+v; t) \exp \left(- \int_{x+n}^{x+v} \gamma(y; t) dy \right) dv$$

and, evaluating (B.24) at $x+n$:

$$N(x;t) = \int_0^{x+n} D(x+v, t) \exp \left(- \int_0^{x+v} \gamma(y, t) dy \right) dv + N(x+n; t) \exp \left(- \int_0^{x+n} \gamma(y, t) dy \right)$$

This equation was obtained by Bennet and Horiuchi (1981: 210) in its discrete version. If we assume that the population is closed to migration, that is, $A(y; t) = 0$ over the entire age range $[0, \omega]$, the natural growth rate is equivalent to the total $\gamma(y; t) = r(y; t)$, and we have the most widely used version of the Bennet and Horiuchi procedure. It is clear that the absence of migration is not a condition for applying the procedure, but merely a simplification when migration data is unavailable or negligible.

The Bennet and Horiuchi model is applied retrospectively. Since at age ω no one survives, that is, $N(\omega, t) = 0$, equation (B.25) for the last age interval is:

$$N(\omega - n; t) = \int_0^{u_j} D(\omega - n + v, t) \exp \left(- \int_0^{\omega - n + v} \gamma(y, t) dy \right) dv$$

With that value, for the previous group:

$$N(u_i - 2n; t) = \int_0^{u_j - n} D(u_i - 2n + v, t) \exp \left(- \int_0^{u_i - 2n + v} \gamma(y, t) dy \right) dv + N(u_i - n; t) \exp \left(- \int_0^{u_i - n} \gamma(y, t) dy \right)$$

and so on up to any exact age equal to or greater than zero, since the valuation of (B.25) depends only on the natural growth rates $\gamma(y; t)$, on the deaths $D(x + y, t)$ of the age interval $x + n$ and on the population at the end $N(x + n; t)$, but not on people under x years of age.

From our definition of annual population density in (B.3) it is clear that the population of the age interval $[x, x + n]$ is:

$${}_n P_x(t) = \int_x^{x+n} N(y, t) dy \quad (B.26)$$

And if we assume that the annual density varies linearly within the age range:

$${}_n P_x(t) = \frac{1}{n} [N(x; t) + N(x + n; t)] \quad (B.27)$$

Let ${}_n P_x(t)$ be the population linked to the deaths derived from the retrospective application (B.25), then the coverage of the deaths with respect to the actual population is:

$$\frac{{}_n P_x(t)}{{}_n P_x(t)} \quad (\text{B.28})$$

This is indeed Bennet and Horiuchi's proposal for correcting the relative coverage of deaths. It is important to remember that model (B.24) is based on the assumption that the coverage level is the same for all ages. When illustrating its application to the case of Mexico in Chapter 2, we discussed the diagnosis when the value of c is not the same for all ages considered.

The adjusted mortality rates are:

$$iK_m(t) = \quad (\text{B.29})$$

where $iK_m(t)$ corresponds to those obtained from registered deaths and census

B.4 Adaptation to the discrete case

When working with completed ages, the generic length n of the age interval is generally 1 (simple or expanded ages) and 5 (five-year groups). The left subscript n is commonly omitted when it equals 1. Here we stick with the general case of n years.

The integral over the **natural growth rates** can be broken down into intervals of equal length n . To simplify the notation, let's assume that the difference $x - a$ is an exact multiple of n , so that:

$$\int_a^x \frac{dI_y}{I_y} = \sum_{j=0}^{(x-a)/n} \frac{dI_{a+jn}}{I_{a+jn}} \quad (\text{B.30})$$

where again the letter n , below the subscript of the summation, indicates that it should be increased by n .

By the first mean value theorem for integrals, we know that there exists ξ —the mean value—such that:

$$\int_a^x I(y|t) dy = n I(\xi|t) (x - a) \quad \text{OR}$$

where $a < \xi < x$ and:

$$\min_{x < y < x-n} \gamma(y, t) < \gamma(\xi, t) < \max_{x < y < x-n} \gamma(y, t)$$

Since a rate is always an annual per capita average, regardless of the length of the age interval or calendar time, and $r(x; t)$ is an average rate given the age interval $[x, x+n]$, we can assimilate it to the group rate, that is, $r(x; t) = \frac{1}{n} \int_x^{x+n} r(u; t) du$ with which, when replacing in (B.30) and for total growth, net migration and mortality:

$$\begin{aligned} r_a(x; t) &= \frac{1}{n} \int_x^{x+n} r(u; t) du & R_a(x; t) &= \int_x^{x+n} r(u; t) du \\ A_a(x; t) &= \frac{1}{n} \int_x^{x+n} A(u; t) du & U_a(x; t) &= \int_x^{x+n} U(u; t) du \end{aligned} \quad (B.31)$$

where $U_a(x; t)$ is the specific mortality rate for the age interval $[x, x+n]$. We can write equation (B.12) as:

$$N(x; t) = N(a; t) \exp \{ -R_a(x; t) + A_a(x; t) - U_a(x; t) \} \quad (B.32)$$

If we apply the mean value theorem of integrals to (B.26):

$$\int_x^{x+n} N(y; t) dy = n N(x + \xi; t)$$

we substitute in the second equality in (B.11):

$$\ln \left\{ \frac{N(x; t)}{N(a; t)} \right\} = \ln \left\{ \exp \{ -R_a(x; t) + A_a(x; t) - U_a(x; t) \} \right\} = -R_a(x; t) + A_a(x; t) - U_a(x; t) \quad (B.33)$$

We take the exponential on both sides:

$$\frac{N(x; t)}{N(a; t)} = \exp \{ -R_a(x; t) + A_a(x; t) - U_a(x; t) \}$$

and we clear:

$$N(x; t) = N(a; t) \exp \{ -R_a(x; t) + A_a(x; t) - U_a(x; t) \}$$

If we assume that the average value of the integral is equal to the midpoint of the interval, that is, $\xi = x + n/2$, we can write the above equation as:

$$\begin{aligned} N(x; t) &= N(a; t) \exp \{ -R_{x,a}(t) + A_{x,a}(t) - U_{x,a}(t) \} \\ &\text{if } x = a \\ &\text{if } x > a + n \end{aligned} \quad (B.35)$$

where g expresses any of the age-specific rates (r , A , M or τ) and l the respective accumulation (i , A , U or T).

If we divide both sides of (B.34) by the population aged a years or older:

$$\frac{p(f)}{nb_{a+}(t) \exp \left\{ - \int_t^{t+h} R_{x|a}(t) + r_{eA_{x,a}(t)} \sim nU_{x,a}(t) \right\}} = \frac{77r}{77r} \quad (B.36)$$

where ${}_nC_{x,a+}(t)$ is the age structure of people aged a years or older.

Let $K(t, t+h)$ denote the person-years lived or **time lived** by the total population between times t and $t+h$, with h measured in years. Its value is given by

$$K(t, t+h) = \int_t^{t+h} P(y) dy \quad (B.37)$$

This equality has the following explanation. Let us consider a small time interval dy measured in years (perhaps a thousandth of a second is still “large”), such that the population $P(y)$ does not change during that period. Since each and every one of the $P(y)$ individuals lives dy years, collectively they live $P(y) dy$ years in that small time interval. Since the definite integral, in the Riemannian sense, is the sum of the function (the population) over **all** the small—actually infinitesimal—intervals of the variable (time), after h years, the right-hand side of (B.37) represents the person-years lived.

If we introduce age, ${}_nK_x(t, t+h)$ are the person-years lived by the population in the half-open interval of exact ages $[x, x+n)$ between the times t and $t+h$:

$$\begin{aligned} {}_nK_x(t, t+h) &= \int_t^{t+h} {}_nP_x(y) dy \\ &= \frac{(e + -L h) - t P +}{qo \setminus} / p \\ {}_nC_x(t, t+h) &= {}_K^{\wedge} t+h) \quad (B-38) \end{aligned}$$

where, similarly to the population at a point in time, for the time lived during the generic period of h years we can establish:

$$K(t, t+h) = \sum_{x=0}^{Uj-71} {}_nK_x(t, t+h) \quad (B.39)$$

It is clear that:

$$\sum_{x=0}^{Uj-71} {}_nC_x(t, t+h) \sim j \quad (B.38')$$

In reality, it is practically impossible to determine the population size over such short time intervals, even a day or a week, since this would require a large amount of demographic information (births, deaths, and migrations) that is not available in our countries, given the high degree of disaggregation by age and time. Thus, to estimate lifespan, mathematical models of population growth, such as the geometric and exponential models, can be used. We prefer the latter because it is consistent with the definition of rate in Demography. Indeed, let us assume that the population grows exponentially at a constant rate r :

$$P(t + y) = P(t) e^{ry}$$

Therefore, the person-years lived between t and $t + h$ are:

$$\frac{K(t, t + h)}{P(t)} = \int_t^{t+h} P(t) e^{ry} dy = \frac{e^{Rh} - 1}{r} P(t + h) \sim P(t) \quad (\text{B.40})$$

either

A rate in Demography is defined as the quotient resulting from dividing the events that occurred in a period of time by the person-years lived by the population during the same interval, thus giving the demographic growth rate:

$$r(t, t + h) = \frac{P(t + h) - P(t)}{P(t)h}$$

is consistent with (B.40).
both sides of (B.34) between t and $t + h$:

$$\begin{aligned} nP_x(t; t + h) &= \int_t^{t+h} nP_x(y) dy \\ &= \int_t^{t+h} \{ nN(a; t) \exp\{-nR_{xja}(t, t + y) + nA_{xj}(t, t + y) - nU_{xja}(t, t + y)\} dy \end{aligned}$$

or

$$nA_{xj}(t, t + h) = \int_t^{t+h} nN(a; t) \exp\{-nR_{xja}(t, t + y) + nA_{xj}(t, t + y) - nU_{xja}(t, t + y)\} dy$$

(B.41)

where now the growth rates, net migration and mortality (r, A, y) correspond to the period of h years.

We can now write equation (B.18) as:

$$\ln \{n^{x,a}(t, t + h)\} = \ln \{b_{a+}(t, t + h)\} + \int_t^{t+h} \{ -nR_{xja}(t, t + y) + nA_{xj}(t, t + y) - nU_{xja}(t, t + y) \} dy$$

³ In Sweden, although there is continuous population records, the time lived is approximated by rounding the time lived to two-month periods of the year.

If we decompose net migration rates into immigration and emigration rates, say ${}_nA_x = {}_nI_x - {}_nE_x$, we can write the above equation as:

$$\begin{aligned} \{ {}^c n_x a + (t; t+h) \} &= \{ {}^b a + (t; t+h) \} - \{ {}^k r n^R x, a + (t; t+h) \} + \\ &+ \{ {}^k i. n^I x, a + (t; t+h) \} - \{ {}^k i n^E x, a + (t; t+h) \} - \{ {}^k p n U x, a + (t; t+h) \} \end{aligned} \quad (B.42')$$

where I and E are the accumulations of immigration and emigration rates, respectively, with the general structure (B.35).

The Bennet and Horiuchi model (B.25) is:

$$N(x; t, t+h) = nD_x(t; t+h) \exp \{ n\gamma_x(t, t+h)/2 \} + N(x+n; t, t+h) \exp \{ n\gamma_x(t, t+h) \} \quad (B.43)$$

$$nKEx(t, t+h) = - [N(x; t, t+h) + N(x+n; t, t+h)] \quad (B.44)$$

Note that it is not necessary to multiply by the length of the time interval h ,

Aguascalientes	AG	Morelos	MO
Baja California	BC	Nayarit	NA
Baja California Sur	BS	Nuevo León	NL
Campeche	AC	Oaxaca	OA
Coahuila	CO	Puebla	PU
Colima	CL	Querétaro	QT
Chiapas	CS	Quintana Roo	QR
Chihuahua	CH	San Luis Potosí	SL
Mexico City	CM	Sinaloa	YE
Durango	DU	Sonora	AH
Guanajuato	GT	Tabasco	SW
Warrior	GR	Tamaulipas	TA
Gentleman	HI	Tlaxcala	TX
Jalisco	JA	Veracruz	VE
Mexico	ME	Yucatán	YU
Michoacán	MY	Zacatecas	ZA

D. The life table

A life table, or mortality table, is a probabilistic model that describes the history of a cohort—usually fictitious—until the extinction of its last member through death. The table is composed of various biometric functions:

${}_xL$ Survivors at the exact age x of an initial cash or radix ${}_xL_0$

${}_n d_x$ Deaths between the exact ages x and $x + n$. Its value is given by:

$${}_n d_x = {}_xL - {}_{x+n}L \quad (D.1)$$

${}_n p_x$ Probability that a survivor of age x has of living an additional n years:

$${}_n p_x = \frac{{}_{x+n}L}{{}_xL}$$

${}_n q_x$ Probability that a survivor of age x has of dying before n years:

$${}_n q_x = 1 - {}_n p_x \quad (D.2)$$

From the axioms of probability and definition (D1) we have the following closure property:

$${}_n p_x + {}_n q_x = 1$$

${}_n L_x$ Person-years lived between the exact ages x and $x + n$ by the cohort in the table. Its strictly mathematical value is given by:

$${}_n L_x = \int_x^{x+n} \ell_y dy \quad (D.3)$$

This equality has the following explanation. Suppose that ℓ_y is a continuous function between the exact ages x and $x + n$, and let dy be a small period measured in years (perhaps a thousandth of a second is still "large"). At the end of that

Survivors live dy years and the set lives a total of $\int_{x}^{x+n} dy$ years. Since a definite integral, in the Riemann sense, is the sum of the function over all infinitesimals of time covering the range of variation (from x to $x + n$), then the person-years lived by the cohort in the table are the right-hand side of (D.3).

${}_n a_x$ Person-years lived between the exact ages x and $x + n$ due to deaths occurring in that age interval. Its value is clearly bounded between 0 (all deaths occur at the exact age x) and n (all occur at age $x + n$).

It is customary to omit the left subscript n when referring to a year ($n = 1$).

The person-years lived by cohort ${}_n L_x$ are then obtained as the sum of the years lived by the survivors (n years for each one) and by the deaths:

$${}_n L_x = n \int_{x}^{x+n} l_x dx + \int_{x}^{x+n} {}_n d_x dx \quad (D.4)$$

whereby, incorporating (DI):

$${}_n L_x = n \int_{x}^{x+n} l_x dx + \int_{x}^{x+n} {}_n d_x dx \quad (D.4')$$

If we assume that deaths are uniformly distributed over the age interval, i.e., ${}_n d_x = \frac{{}_n d_{x+n}}{2}$, then the person-years lived are:

$${}_n L_x = \int_{x}^{x+n} l_x dx + \frac{{}_n d_{x+n}}{2} n \quad (D.4'')$$

Assuming that deaths are uniformly distributed is equivalent to assuming that the survivors function decreases linearly within the age period of n years, which is the same as the numerical integration by means of a trapezoid in (D.3), i.e., the equality in (D.4'').

In demography, a rate is defined as the ratio of events occurring in a given time interval to the person-years lived by the population during the same period. It expresses an annual average per capita of events, regardless of the length of the interval. Therefore, for a life table, we have:

$$im_x = \frac{{}_n d_{x+n}}{{}_n L_x} \quad (D.5)$$

If we introduce (DI) into (D.4)

$${}_n L_x = n \int_{x}^{x+n} l_x dx + \int_{x}^{x+n} {}_n d_x dx$$

we clear

$$\int_{x}^{x+n} l_x dx = n \int_{x}^{x+n} l_x dx + \int_{x}^{x+n} {}_n d_x dx$$

we substitute in (D.2):

and we divide numerator and denominator by ${}_nL_x$, by (D.5):

$${}_nq_x = \frac{{}_{77}n,mx}{1 - \frac{{}_{77}n,mx}{({}_{77}n+r) {}_nT^{\wedge}_x}} \quad {}^{*772,,} = \frac{{}_{77}n,mx}{({}_{77}n+r) {}_nq_x} \quad (D.6)$$

formulas that are due to Chiang.

Andreev and Kingkade (2015: 376) for the separation factor ${}_nq$ were used.

$$\begin{aligned} \text{For men} \quad & \begin{aligned} & 0.1493 - 2.0367 \text{ if } q_0 < 0.0226 \text{ if} \\ & g_0 \leq 0.0244 + 0.0226 < g_0 < 0.0785 \\ & 3.4994 \quad g_0 \text{ or if } g_0 > 0.0785 \end{aligned} \\ \text{For women} \quad & \begin{aligned} & 0.1490 - 2.0867 \text{ if } g_0 < 0.0170 \text{ if} \\ & g_0 \leq 0.0438 + 0.0170 < g_0 < 0.0658 \\ & 4.1075 \quad g_0 \leq 0.3141 \text{ if } g_0 > 0.0658 \end{aligned} \end{aligned} \quad (D.7)$$

and for the next four ages those suggested by the United Nations (1983) in its 1982 model tables:

$$a_1 = 0.44, a_2 = 0.47, a_3 = 0.49 \text{ and } a_4 = 0.5 \quad (D.8)$$

In the state case, when estimating the probabilities of dying between 1 and 5 years of age ${}_4q_1$ (see chapter 7), the formulas for the Coale and Demeny (1983) West model were used:

$$\begin{aligned} {}_4q_1 &= \begin{aligned} & 1.6533 - 3.013 \quad q^* \text{ for men} \\ & 1.5237 - 1.627 \quad q^* \text{ for women} \end{aligned} \quad \text{with } q = \begin{cases} q_0 & \text{if } g_0 < 0.1 \\ 0.1 & \text{if } g_0 > 0.1 \end{cases} \quad (D.8') \end{aligned}$$

From five years of age onwards, the exponential growth formula was used for individual ages

$$g^* = 1 - \exp \{-m_x\} \quad (D.9)$$

For the five-year age groups 5-9 and 10-14 years, the separation factors suggested by Coale and Demeny (1983) were used:

$${}_5q_5 = \frac{{}_5m_5}{1 + 2.7557725 \quad \text{and } {}_5q_{10} = \frac{5.5 \text{ million}}{1 + 2.5577140}} \quad (D.10)$$

$$5\% = 1 - \exp \{-55\} \quad (D.11)$$

¹The general Reed-Merrell formula is:

$${}_nq_x = 1 - \exp \{-n \cdot m_x - 0.008n^3 \text{STO}\}$$

and if $n = 5$, then $0.008 \times 125 = 1$.

In the case of annual intervals, solving for the rate in (D.9) gives:

$$m_x = -\ln\{1 - q_x\} \quad (D.12)$$

For groups 5-9 and 10-14, when clearing in (D.10):

$$5^{*5} = \frac{5}{5 - 2.75} {}_5g_5 \quad \text{and} \quad 5^{*10} = \frac{5^{*10}}{5 - 2.5} {}_5g_{10} \quad (D.13)$$

and from 15-19, when clearing in (D.11):

$$^{25-4} \ln\{1 - q_x\} - 5 \quad (D.14)$$

Person-years lived can also be obtained by solving for (D.5):

$$nL_x = \frac{he}{r^{n+1}} \quad (D.4''')$$

T_x Person-years lived from age x . Its value is given by:

$$T_x = \sum_{y=x, n}^{\infty} nL_y \quad (D.15)$$

where u is an extremely advanced age, the limit of human life, that is, one that no one survives:

$$L = 0$$

e_x Life expectancy at age x , that is, the average number of years that each of the survivors at that age has left to live:

$$= f$$

$$(D.16)$$

To obtain the mortality table and, from it, life expectancies, it is necessary to find a way to convert some measure of observed mortality into one of the biometric functions of the table. This is generally done by assuming that the observed and table mortality

$${}_n m_x = {}_n M_x$$

where ${}_n M_x$ is the observed mortality rate. With the observed rates and formulas (2.25) or (2.26) the probabilities ${}_n q_x$ are obtained and with them the table is drawn up, for which a value is arbitrarily fixed for the radix ${}_n l_0$, generally one, one hundred thousand or one million

When an abbreviated mortality table was available (0, 1-4 years and five- year groups), the transition to single ages was made using the parameterized model of Heligman and Pollard (1980):

$$q_x = A(B^{B+x}r + D \exp \left\{ \frac{x}{F} \right\})^2 + 1 - \frac{GH^x}{GH} \quad (D.17)$$

The model parameters (A , B , D , E , F , G and H) were estimated using the **UNABR subroutine** of the United Nations **MortPak** computing package (United Nations, 1988).

Coale and Kisker (1990) found that theoretical patterns of age-related mortality in old age, including Gompertz's law (GH^x) in the last element of (D.17), are not adequate; concluding that the logarithm of the ratio of two successive mortality rates — here we adopt the probabilities of dying — follows an approximately linear decreasing pattern:

$$\ln \frac{n^z + n}{n^z - n} - \ln \frac{n^{z+1} + n}{n^{z+1} - n} = K_x \quad \text{with } K_x = \frac{\ln \frac{n^z + n}{n^z - n} - \ln \frac{n^{z+1} + n}{n^{z+1} - n}}{1} \quad \% = 0, 1, 2, \dots, j \quad (D.18)$$

where z is an advanced age beyond which the Gompertz law is no longer suitable and j is the number of n - year intervals between z and u . If we sum over the j n - year age intervals in (D.18):

$$\sum_{i=1}^j \ln \frac{n^z + n}{n^z - n} - \ln \frac{n^{z+1} + n}{n^{z+1} - n} = \sum_{i=1}^j K_{z+i} \quad \text{with } K_{z+i} = \frac{\ln \frac{n^z + n}{n^z - n} - \ln \frac{n^{z+1} + n}{n^{z+1} - n}}{1}$$

where from,

$$P = \frac{n^z + n}{n^z - n} \cdot \exp \left(\sum_{i=1}^j K_{z+i} \right) \quad \text{with } j = \frac{u - z}{n} \quad (D.19)$$

$z = 85$ and $u = 110$ in all cases. For both the country as a whole and the federal entities, by fitting the Heligman and Pollard model, we obtain the age-displayed mortality ratios q_x . Thus, the value of j is:

$$j = \frac{110 - 85}{n}$$

whereby, since $gnjg = 1$:

$$P = \frac{n^z + n}{n^z - n} \cdot \exp \left(\sum_{i=1}^j K_{z+i} \right) \quad \text{with } j = \frac{u - z}{n} \quad (D.20)$$

It is not possible to assign a value to $\ln 0$, since the logarithm of zero is undefined and, therefore, the rate cannot be valued using (D.12). In fact, under the exponential model (D.9), the rate tends to infinity as age approaches o_j , that is,

$$q_x = 1 - \lim_{x \rightarrow \infty} (\exp \{-m_x\}) = 1 - 0 = 1$$

To calculate the person-years lived for 109 years, we recover the linear model of Coale and Kisker with mortality rates:

$$N_{109} = 2 \cdot \kappa_{108}^{-k_{107}} \cdot \kappa_x - \int_0^t \tau \gamma_{1x-1}$$

Given that we know the probabilities up to **108** years and from the exponential model the mortality rates from **106** to **108**, we can evaluate **κ_{107} and κ_{108}** , from where,

$$\frac{N_{109}}{N_{108}} = \frac{2 \cdot \kappa_{108}^{-k_{107}} \cdot \kappa_{108} - \int_0^t \tau \gamma_{1x-1}}{2 \cdot \kappa_{108}^{-k_{107}} \cdot \kappa_{107}}$$

Taking the exponential on both sides and solving for:

$$\kappa_{109} = \kappa_{108} \exp \{2 \cdot \kappa_{108}^{-k_{107}} - R_{107}\}$$

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